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Review and Analysis of Selected Items Management (SIM) Inventory Program Aboard US Surface Ships

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The purpose of this MBA project is to carry out an exploratory study and conduct an analysis to determine if there are any correlations between shipboard supply management practices/priorities and SIM Issue Effectiveness rates. Shipboard SIM inventories range from approximately 300 to 350 line items on average per ship. While SIM items constitute only a small portion of the ship's entire COSAL spare parts inventory, they are critical to the ship's material condition and to its preventive and corrective maintenance programs. Consequently, effective and efficient SIM inventory control is crucial and has a significant impact on the ship's mission readiness. However, surface ships reporting their monthly inventory and performance data to the Type Commander indicate some of the ships are not meeting their SIM Issue Effectiveness goals. The project investigated the variances to determine if they can be explained using correlations with other variables. In addition, the authors analyzed SIM inventory to determine if a Business Processing Reengineering (BPR) through virtual stock consolidation with a shift in emphasis from individual shipboard support to a more global level can result in risk mitigation of SIM stock outs. The project compared common commercial inventory control practices to shipboard inventory procedures to examine possible application of best practices.

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REVIEW AND ANALYSIS OF SELECTED ITEMS MANAGEMENT (SIM) INVENTORY PROGRAM ABOARD US SURFACE SHIPS

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Submitted in partial fulfillment of the requirements for the degree of

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ABSTRACT

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Mark Ivan Axinto

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Michael Scott Giles

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LIST OF ABBREVIATIONS AND ACRONYMS

3-M - Maintenance and Material Management

ACR - Allowance Change Request

AEF – Air Expeditionary Force

ASI – Afloat Shore Interface

AT – Allowance Type

ATG – Afloat Training Group

BOM – Bill of Materials

BPR – Business Process Reengineering

CASREP – Casualty Report

CIRF – Centralized Intermediate Repair Facility

CMP – Continuous Monitoring Program

CNSP - Commander Naval Surface Force Pacific

CO – Commanding Officer

COG – Cognizance Symbol

COMNAVSURFPAC – *see CNSP*

COSAL - Coordinated Shipboard Allowance List

CTF – Commander Task Force

DBI - Demand Based Item

DLA – Defense Logistics Agency

DLR – Depot Level Repairable

EOQ – Economic Order Quantity

FBM – Fleet Ballistic Missile

FIMARS – Force Inventory Management Analysis Reporting System

FISC – Fleet and Industrial Supply Center

FLSIP – Fleet Logistics Support Improvement Program

GAO – Government Accountability Office

ICP – Inventory Control Point

ILS – Integrated Logistics Support

JIT – Just In Time

MATCONOFF – Material Control Officer

MCC – Material Control Code

MDS – Maintenance Data System

MPS – Master Production Schedule

MRC – Maintenance Requirements Card

MRP – Material Requirements Planning

MTBD – Mean Time Between Demand

MTBF – Mean Time Between Failure

MTBR – Mean Time Between Replacement

MTT – Mean Transit Time

NAVICP – Naval Inventory Control Point

NAVSUPSYSCOM – Naval Supply Systems Command

NIMS – National Inventory Management Strategy

NON-DLR – Non-Depot Level Repairable

O&MN – Operation and Maintenance - Navy

OMMS-NG - Organizational Maintenance and Material System-Next Generation

OPTAR – Operating Target

OST – Order and Shipping Time

PMS - Planned Maintenance System

R-Supply – Real Time Supply

RFI – Ready For Issue

RO – Requisition Objective

RP – Reorder Point

SIM - Selected Item Management

SNAP - Shipboard Nontactical Automated Processing system

SORTS – Ship's Operation, Readiness, and Training Status

SUADPS - Shipboard Uniform Automated Data Processing System

SUPPO – Supply Officer

TYCOM - Type Commander

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I. INTRODUCTION

A. BACKGROUND

The Type Commander (TYCOM) for surface forces in the Pacific Fleet is the Commander, Naval Surface Force Pacific (COMNAVSURFPAC or CNSP). As the TYCOM of the Pacific surface fleet, some of its responsibilities are training, readiness, and material/logistics support of its fleet. COMNAVSURFPAC, in conjunction with the Naval Supply Systems Command (NAVSUPSYSCOM) and the other TYCOMS, have set forth shipboard inventory policies and inventory goals to make certain that the US Navy warships are adequately supported. One of the TYCOM key inventory goals is the effective and efficient management of Selected Items Management (SIM) items, sometimes referred to as SIM deck. Selected Items Management is synonymous with Demand Based Items (DBI) management. Consequently these terms are used interchangeably throughout this professional report. SIM items or DBI are a subset of the shipboard's spare parts inventory, which are defined thoroughly in the succeeding chapter.

There have been numerous studies conducted on wholesale inventory levels, but there has been little to no attention paid to retail inventory at the shipboard level where the "rubber meets the road". This is where the operational impact of inventory deficiencies is immediately observed affecting the ship's combat and material readiness.

B. PROJECT OBJECTIVES

The objectives of this professional report are three-fold. The first objective is to investigate whether shipboard inventory supply management practices correlate with SIM or DBI effectiveness. The project theorizes that there is a correlation between competing shipboard management requirements and supply issue effectiveness rates. This project attempts to assess the impact of this correlation in satisfying the TYCOM's SIM inventory goals. Additionally, this project examines shipboard management practices of ships that consistently exceed SIM goals to identify if there are correlations between these practices and SIM effectiveness. Finally, the project also conducts a review of ships' SIM inventory to determine the feasibility of and potential value added from performing a business process reengineering on shipboard spare parts inventory, specifically SIM items.

C. METHODOLOGY

The project team applied theories, concepts, and principles of operational logistics and employed statistical analysis techniques learned in the previous 18 months of the MBA curriculum. Literature review and material background information were obtained from unclassified DOD and Navy documents, GAO reports, past thesis reports, professional logistics and management journals, and other published inventory and logistics management materials cited herein. The authors obtained ships' actual historical inventory and requisition data collected during a six month window between 2004 and 2005 via the Continuous Monitoring Program (CMP) through the auspices of Afloat Training Group Pacific in San Diego. The team also sent out survey questionnaires to Cruisers' and Destroyers' Supply Officers (SUPPOS) that are under the cognizance of COMNAVSURFPAC to ascertain the SUPPOS' managerial focus and priorities, which were followed by telephone interviews to reinforce or clarify specific items of interest in their survey responses. Furthermore, both project team members have had prior assignments as SUPPOs on surface warships, and drew upon those experiences to explain or verify particular issues or points.

Survey results and raw inventory and demand data are included as appendices to this report. Statistical analysis was performed to determine correlations between supply management practices and SIM effectiveness using the Pearson correlation coefficient.

D. SCOPE OF PROJECT

The raw inventory and demand data utilized to perform the analysis came from CG47 class cruisers and DDG class destroyers that are under COMNAVSURFPAC's operational control and responsibility. In the interest of focusing the research, no attempt was made to gather data from other classes of ships nor from ships in the East Coast TYCOM (Commander, Naval Surface Force Atlantic Fleet). Although there are many policy similarities in procedures, goals, requirements, etc. between the West Coast and East Coast TYCOMs, and while general shipboard inventory practices and challenges of other classes of ships and cruisers/destroyers may be alike, there may still be subtle but substantial differences in data that may or may not influence the result of the analysis. This MBA professional report limits the scope of the study and its analysis to CG47 class cruisers and destroyers in the Pacific fleet under COMNAVSURFPAC. The project is focused on inventory effectiveness as it relates to mission accomplishment and does not pursue any analysis pertaining to the costs and cost efficiencies. However, it must be emphasized that cost is a very important and persistent factor that affects inventory management

Moreover, the project limits its scope to the retail inventory at the shipboard level and does not attempt to address any policies, processes, and procedures pertaining to the wholesale level of inventory usually maintained at Fleet and Supply Support Centers (FISC), Defense Logistics Agency Depots, and managed by the Inventory Control Points (ICP).

E. ORGANIZATION OF REPORT

The MBA report is organized into eight chapters. After the introductory Chapter, Chapter II of this report introduces the concepts and principles of the shipboard inventory system. Chapter III introduces the issues of SIM and its management concerns. Fundamentals and concepts of inventory control in the commercial environment are discussed in Chapter IV. Chapter V touches on the primary differences between the shipboard environment and commercial industries as these relate to inventory control and management. Chapter VI contains statistical analysis using the Pearson correlation statistic. Potential application of Business Process Reengineering, as it relates to SIM inventory, is discussed in Chapter VII. Finally, Chapter VIII provides conclusions, recommendations, and suggestions of areas for further studies. Pertinent data and informational materials used in the project are provided in the appendices.

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II. SHIPBOARD INVENTORY CONTROL FUNDAMENTALS

A. INTRODUCTION

Surface combat ships of the US Navy are designed and equipped to be self sufficient in terms of spare parts support for a sustained number of combat days. Surface ships, especially the CG47 cruiser class of ships, have evolved over the years to become more complex and sophisticated weapon systems platforms. For example, the Aegis weapons systems suite on a cruiser or destroyer is one of the most capable combat systems as well as one of the most complicated systems aboard a warship. These complex systems require periodic preventive maintenance and repair work in case of system failures to keep them in top combat readiness condition. The repairs and maintenance work, more often than not, require parts replacement. Thus, US Navy surface ships are outfitted and are required to stock spare parts inventory aboard. "An important motive for carrying spare parts inventory is the wish, and often need, to stock such numbers of spares as will allow the users of end-products or plants the luxury of being independent of their vendors."[1] In an operational environment without constraints, an organization would simply stock every possible piece of component without regard to space, costs, usage, etc. Unfortunately this is not so; the challenge to managers is finding the optimal inventory levels against the constrained elements. "…this requires careful forecasting of demand for spares through the lifecycle of the equipment and an adequate allocation of spares within the inventory system."[2]

The principal and primary outfitting methodology for determining spare parts inventory levels aboard US Navy warships is the Coordinated Shipboard Allowance List (COSAL). The Naval Inventory Control Point (NAVICP-Mech) in Mechanicsburg, Pennsylvania, under the joint direction of NAVSUP and the responsible hardware systems command prepare and publish the COSAL for each ship. NAVICP-Mech has responsibility for supporting and ensuring that weapon systems platforms are adequately

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[1] Petrovic, R., Senborn, A., and Vujosevic, M., *Hierarchical Spare Parts Inventory Systems*, p.14

[2] Ibid., p. 21

supported in spare parts stock, both wholesale stock (ashore inventory) and retail stock aboard the ships. "All new construction/major conversion/modernization or overhauled ships, except Fleet Ballistic Missile (FBM) submarines, are provided a COSAL [including the initial spare parts allowance or required inventory quantities to carry] that has been prepared [allowance quantities computed] using the Fleet Logistics Support Improvement Program (FLSIP) in accordance with the policy and criteria outlined in OPNAV Instruction 4441.12 series."[3] NAVICP-Mechanicsburg and the FLSIP utilize sophisticated mathematical algorithms and formulae to calculate initial stocking levels of spare parts based on numerous factors such as, estimated Mean Time Between Failures (MTBF) of equipment, Order and Shipping Time (OST), Safety Levels, Economic Order Quantities (EOQ), historical usage data for similar systems if available, costs of spare parts, etc.

B. COSAL

The overarching mechanism for determining repair parts inventory stock levels and inventory allowances aboard all US warships is the Coordinated Shipboard Allowance List (COSAL). Many years ago, the COSAL was literally a bulky manual listing spare parts that eventually evolved into an automated and integrated inventory system. Generally, the COSAL provides both technical and supply information, which makes it an Integrated Logistics Support (ILS) document. It is a technical document to the extent that it describes the ship's equipment, systems, component breakdowns, operating characteristics, technical manuals, etc., and it is also a supply document since it lists spare parts required to be carried in shipboard stock to achieve maximum self-supporting capability for an extended period of time. Purportedly, the COSAL is designed to provide the warship with a sustained level of material support for 90 combat days without replenishment and is tailored to a particular ship class, because each ship class has a different weapon systems configuration. Once implemented or installed aboard the ship, the COSAL is updated periodically, usually on a monthly basis, via an

[3] NAVSUP Publication 485, *Naval Supply Afloat Procedures, Volume 1*, Sep 2004; 2090, p.163

automated ship to shore interface called an ASI (Afloat Shore Interface). The updates account for or react to changes in the ship's configuration and include addition, deletion, and changes in the allowance quantity for items of stock. Similar to the COSAL, ASI updates are also ship and class specific. An example of a change in a ship configuration includes a newly installed weapon system or a change in a major engine component, or a removal of communication suite.

1. Depot Level Repairable versus Non-DLR Items

Repair parts listed in the COSAL can be categorized into two major categories: Depot Level Repairable (DLR) items and non-DLR items. DLR items are usually high value components that are deemed too costly to simply dispose, that are deemed repairable by higher echelons and can be returned back to inventory in a Ready For Issue (RFI) condition after repairs have been completed at pre-designated depot repair facilities. DLR items are pre-designated by higher authorities and are identified by coded cognizance symbols and a Material Control Code (MCC) as illustrated in Table 1.

Table 1. DLR Material Identification Codes

COGNIZANCE SYMBOLS	Material Control Codes
7R, 7G, 7E, 7H, 0R, 0Q, 4Z, 8N, 6K, 6R, etc	H, E, X, G, and Q

Source: NAVSUP P-485, *Afloat Supply Procedures, Appendix*

DLR stock allowance quantities are fixed and can not be adjusted by shipboard personnel. Allowance changes for DLRs must be requested through NAVICP-Mechanicsburg via an Allowance Change Request (ACR). DLR requisitioning and replenishment is on a one vs. one turn-in basis. A stock DLR is replenished if and when an order and a used carcass of the same item is turned-in for repair. There are some unique procedures involved in the DLR inventory and requisitioning process, which are beyond the scope of this professional report.

All other COSAL spare parts not deemed repairable according to the cognizance symbol and MCC are by definition non-DLR items. SIM and DBI parts inventory fall under this classification. Allowance or required inventory quantities of non-DLR items can be adjusted from its original COSAL allowance quantity by shipboard personnel, based on the usage and fluctuation of shipboard demands. Some of the more common cognizance symbols attributed to non-DLR items are listed in Table 2, below.

Table 2. Cognizance Symbols of Non-DLR Repair Parts

COG SYMBOL	DESCRIPTION
9C	Construction items
9G	General spare part items
9N	Electronic spare parts
9E	Electrical items

2. Allowance Type Codes

Allowance Type (AT) codes are numeric codes in the inventory records identifying and/or explaining why a piece of spare part is carried in stock or why an item is in the inventory control records. There are nine AT codes in the COSAL as tabulated in Table 3.

C. FUNDING FOR STOCK AND REPLENISHMENTS

Ships are allocated Operations and Maintenance-Navy (O&MN) appropriated funds by the TYCOM in the form of Operating Target (OPTAR) grants. OPTAR grants are target amounts that serve as the ship's annual budget, but are distributed to the ships in quarterly allotments. As the title of the lead appropriation implies, the purpose of the OPTAR is to finance the day to day operation and maintenance requirements of the Navy. Basically, the ship's OPTAR also pays for its spare parts inventory including related costs, such as ordering costs, transportation costs, and any carrying costs associated with the inventory.

Table 3. COSAL Allowance Type Codes

AT Code	Meaning	Description
AT1	COSAL item	A shipboard repair part is carried in stock as mandated by the COSAL.
AT2	Aviation support item	Spare parts are carried to support embarked aircraft; i.e. helicopter on a cruiser
AT3	COSAL/AV item	A repair part has a dual/common application.
AT4	Demand Based Item	Non-DLR spare parts that are not initially determined to be carried in stock, but actual usage/demand and frequency signify that such must be carried. These items require Selected Item Management (SIM) attention and is the focus of this professional report.
AT5	TYCOM special item	Items that are directed/dictated by the TYCOM to be carried in shipboard stock. These are not COSAL items.
AT6	Excess item	Items that are deleted or items that have their quantities decreased from a subsequent ASI update. Supposedly, the ship will not have any use of the deleted items. The ship normally processes these items for offload.
AT7	Economic Retention item	Items that are excess but its economically prudent to retain onboard because of its low value. Ostensibly, it costs more to process these materials for offload, so they are retained onboard.
AT8	Demand Recording	The first record of a demand or requirement for a repair part. These items do not have inventory quantities.
AT9	Substitute/Alternate item	A substitute/alternate item for another.

Source: NAVSUP P-485, *Afloat Supply Procedures, Appendix*

D. SIM INVENTORY CONCEPT

In any type of inventory system there are usually a small number of materials that move faster, get used more often, or are demanded more frequently than the rest of the inventory. Navy logistics standards and policy makers have devised a mechanism and structure to classify and designate fast moving non-DLR spare parts; targeting these items for intensive inventory management. SIM intensive management entails separate and designated storeroom for SIM items, frequent physical inventory accounting, location audits, more frequent reorders, periodic reviews of items, etc. The rationale for the SIM inventory concept is simply that these high usage items impact the material and operational readiness of surface warships. SIM parts are non-DLR spare parts that can either be an AT1 COSAL allowance item whose demand frequency qualifies it for closer management attention or a purely AT4 DBI part; which by definition is also called SIM. The entire SIM inventory is also commonly known as the SIM deck, from its historical origin when records of individual stock items were maintained by decks of inventory cards.

1. Initial SIM Qualification Criteria

Inventory items may be designated as SIM items based on frequency of demand. Frequency of demand is computed by OMMS-NG whenever SUPPOs execute the periodic review of usage. Initial SIM qualification and designation criteria include:

1.) Spare part must be a non-DLR item,

2.) Part must have had two hits or have been requisitioned at least two times within the last six months for use in a maintenance action (either repair or preventive maintenance).

It is important to note and make a significant distinction at this juncture between demand (or a requisition hit) and quantity demanded. For SIM qualification, it is the number of times (or demand) that an item has been requisitioned that matters, not the quantity requested in each requisition. To illustrate: a requisition for 25 units of a non-DLR widget counts as one demand; another requisition for 1 unit (or any quantity) of the same widget counts as the second demand. The widget would qualify and be designated as a SIM item if these hits occur within a continuous six-month period.

2. SIM Retention Criteria

While the Surface Force Supply Manual requires that SIM qualification reviews be conducted at least quarterly, most ships conduct the reviews monthly, coincident with the monthly financial reporting and inventory global setting. Since usage and demand for parts fluctuate, it follows that SIM inventory may also be changing regularly. Items that no longer meet the criteria are taken out of the SIM deck while new spare parts may be added as new SIM items once the criteria are met. Conversely, SIM items may also be declassified becoming non-SIM items whenever they no longer satisfy the criteria for retention as SIM. The retention criteria for items to remain in the SIM deck:

1.) At least one more demand within a rolling six month period,

2.) Spare part must remain a non-DLR item. Although rare, there are instances when a spare part migrates (re-identified) to a DLR item.

As a result of these periodic reviews and the recalculation requirement, the SIM deck is not a static population of parts but rather a more dynamic subset of the COSAL.

E. PLANNED MAINTENANCE SYSTEM AND 3-M

An effective and successful shipboard preventive maintenance program is crucial to the ship's combat and material readiness. The Planned Maintenance System (PMS) provides the ship with the tools to plan, schedule, and control planned maintenance actions effectively. Navy warships accomplish routine and recurring preventive maintenance through the use of its PMS, which is a key component of the Navy's Maintenance and Material Management (3-M) program. Under the PMS concept, systems, equipment, and their components requiring recurring preventive upkeep or maintenance are identified in the 3-M program. The maintenance procedures, steps, material requirement, and any spare parts replacement needed are described in a very specific Material Requirement Card (MRC) for that equipment for a particular maintenance action. The Navy's 3-M program ties together the ship's configuration management program and the Maintenance Data System (MDS) program. The 3-M MDS program has advanced over the years to become a suite of computer programs that collects information regarding maintenance and repair actions on weapon systems/equipment, including discrepancy, repair action, and if any spare parts are required to effect repairs. Consequently, the ship's 3-M program and the ship's COSAL are analogous to the different sides of the same coin. Both are integral elements to the ship's combat and material readiness. The 3-M MDS and COSAL supply data interface via a computer suite called the Shipboard Non-tactical Automated Processing (SNAP) program. Maintenance data are accessed and inputted via the Organizational Maintenance Material System-Next Generation (OMMS-NG) application software, while supply processes, which include ordering, issuing, receiving, stowing, replenishing, and the associated financial data, are performed in the Real Time-Supply (R-Supply) application software.

F. MATERIAL AND COMBAT READINESS

The status of ship's combat and material readiness are conventionally measured by and reported through the Ships Operations, Readiness, and Training Status (SORTS) reporting program; whereas a Casualty Report (CASREP) is the medium for reporting any capability degradation of equipment and/or weapon systems, or partial or total loss of mission capability that causes the ship's inability to employ its full potential fire power due to either insufficient spare parts support, lack of expertise and training of maintenance personnel, or other such causes. Although it is readily understood that combat readiness also entails some intangible factors, such as leadership, crew morale, quality of the crew, etc., SORTS status reporting are generally the accepted measures of readiness. Unfortunately, the contents of both reports are categorized as classified information.

III. SIM ISSUE EFFECTIVENESS CONCERNS

A. MATERIAL READINESS AND SPARE PARTS INVENTORY

Navy logistics leadership contends that SIM inventory have a direct impact and a measurable effect on shipboard material readiness condition. Accordingly, it mandates a series of inventory goals for SIM items. SIM inventory are scrutinized and are monitored at the TYCOM level. Ships are required to submit a monthly report of their SIM inventory effectiveness (among other inventory reporting requirements) via the Continuous Monitoring Program (CMP). Some of the TYCOM's inventory management goals include: [4]

a.) SIM Issue Effectiveness Rate	≥ 90%
b.) Non-SIM Issue Effectiveness Rate	≥ 85%
c.) Gross Effectiveness Rate	≥ 65%
d.) SIM Not In Stock (NIS)	00
e.) Not Carried (NC)[5]	< 30%
f.) Inventory Range	≥ 95%
g.) Inventory Depth	≥ 90%

The monthly CMP effectiveness reports indicate a wide disparity in issue effectiveness rates among COMNAVSURFPAC surface ships, with some ships not meeting their issue effectiveness goals and others consistently meeting or even exceeding goals. The TYCOM considers these variances an important concern because it can potentially impact the ships' mission readiness. The TYCOM puts heavy pressure on SUPPOS who fail to meet SIM effectiveness goals. "A SUPPO recalled being called on

[4] COMNAVSURFPACINST 4400.1J, *Surface Force Supply Manual*, Appendix

[5] Spare parts that have encountered a demand or have been ordered as a maintenance requirement but have not been provisioned in the COSAL as an allowance item, and have not yet met SIM stocking criteria are called Not Carried (NC) items. Although shipboard inventory managers do not have any control in the initial production of COSAL allowances, the TYCOM also tracks NC rates to assess the effectiveness of the COSAL allowancing development process.

the mat by Afloat Training Group (ATG)/TYCOM and being grilled to explain his ship's rates and what were his plans to fix his effectiveness rates."[6] Issue effectiveness rates are calculated based on the number of requirements, more often referred to as requisitions or demands, that are filled or satisfied immediately from shipboard on-hand stock. Figures 1 and 2 below show the computation formula for both net and gross issue effectiveness rates.

Figure 1. Net Issue Effectiveness Rate[7]

$$\text{Net Issue Effectiveness Rate} = \frac{\text{Number of requisitions issued}}{\text{Total number of requisitions} - \text{Number of requisitions not carried(NC)}}$$

Figure 2. Gross Effectiveness Rate[8]

$$\text{Gross Issue Effectiveness Rate} = \frac{\text{Number of requisitions issued}}{\text{Total number of requisitions}}$$

B. PROBLEMS AND ISSUES

The authors of this professional report contend that there are several variables that conflict and compete for the SUPPO's management attention that can result in the inefficient management of SIM and degradation of issue effectiveness, and therefore negatively impacting the ship's combat readiness posture. Furthermore, the dynamic nature of the SIM deck contributes to the inefficiency and does not allow for forecasting of demand data. Additionally, ships are mobile targets for re-supply, especially while on deployment, such that transportation and routine regular replenishment may become a hit and miss challenge. There are several cases where spare parts re-supply chase the ship from port to port due to the ship's mobility. These missed opportunities to load

6 Telephone interview with SUPPO who preferred to remain anonymous, 07 Oct 2005.

7 COMNAVSURFPACINST 4400.1J, *Surface Force Supply Manual*.

8 Ibid.

replenishment materials can result in stock outs of critical spare parts, which can negatively impact the ship's maintenance effort, and can deprive the ship of its vital weapon systems, thereby degrading its mission capability.

The project explores shipboard management practices to investigate whether the appropriate level of management attention can mitigate or prevent these problems. Furthermore, the authors contend that virtual stock consolidation can minimize stock outs in ships operating simultaneously within an area of operations, mitigating the risk associated with a missed replenishment opportunity

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IV. COMMERCIAL INDUSTRY INVENTORY CONTROL AND MANAGEMENT PRACTICES

A. INTRODUCTION

Every organization in any industry, regardless of whether it operates in manufacturing, retailing, wholesaling, etc., even service organizations, must hold some level of inventory to either support the internal requirements of the organization or to provide supplies to its customers for consumption, resale or redistribution. There are many reasons that would explain why a company would hold stocks in inventory. The principal reasons for holding stock include:[9]

1.) Insurance against higher than average demand,

2.) Insurance against delays in supplier delivery times,

3.) Take advantage of quantity discounts,

4.) Take advantage of seasonal and other price fluctuations,

5.) Minimize delay in production cause by a lack of parts.

One important factor affecting the success of a business venture is its ability to provide for its customers (be it for supplies or services) and users while remaining financially viable and profitable in the long run. Companies incur different types of costs whenever they are holding inventory; these include holding cost, procurement cost, deterioration cost, opportunity cost, etc. For instance, a typical manufacturing company holds 20% of its production as stock, and this has annual holding costs of around 25% of value.[10] Thus, it is not surprising that businesses exert considerable effort on minimizing these costs, while trying to maintain the services and supplies offered to their customers. This is the continuing challenge to all business managers and the crux of inventory control and logistics management – optimizing inventory to maximize customer support and satisfaction while minimizing costs, and also maximizing profits.

[9] Lewis, C.D., *Scientific Inventory Control*, p. 44

[10] Waters, C.D.J., *Inventory Control And Management*, p. 37

Generally, there are two basic approaches to inventory control:[11]

1.) Independent demand systems - use quantitative models to relate forecast demand, order size, and costs.

2.) Dependent demand systems - use production plans directly to calculate stock requirements.

Table 4 compares some of the characteristics of these two approaches. Depending on the type of industry and the type of the prevailing demand system, there are several different methods of controlling and managing inventory. This chapter describes a few of the more common inventory practices in the commercial sector.

Table 4. Dependent and Independent Demand Systems[12]

Independent	Dependent
• Stock Level System • Forecast • Buys & keeps stock until needed • All lines separate • Reactive • Good customer service, if well designed • High stock • Appropriate for end-products	• MRP system • Calculated • Buys & keeps stock until needed • Lines coordinated • Proactive • Very good customer service, if well designed • Low stock • Appropriate for manufacturing components

B. ELEMENTS OF AN INVENTORY CONTROL POLICY

There are three primary variables in inventory control:[13]

1.) Demand systems prevalent in the industry

2.) Replenishment decisions that answer the following questions:[14]

[11] Waters, C.D.J., *Inventory Control and Management*, p. 10

[12] Wild, T., *Best Practice in Inventory Management,* p. 178

[13] Petrovic, R., Senborn, A., and Vujosevic, M., *Hierarchical Spare Parts Inventory Systems*, p. 6

a.) How often should the inventory status be determined?

b.) When should a replenishment order be placed?

c.) How large should the replenishment order be?

3.) Cost as a restraining variable that constrains the answers to the three questions above. Inventory related costs comprise transaction, ordering, carrying, shipping, and may also include opportunity costs associated with holding inventory.

Operation and inventory managers must not lose sight of the central theme of inventory management – that is, having the right material on-hand in the right quantity at the time when the material is needed while concurrently minimizing inventory related costs. Extending this principle to a company's entire inventory gives rise to inventory control policy. Inventory control consists of all the activities and procedures used to ensure the right amount of materials is held in stock,[15] or very simply, what to order, when to order more stock and how much to order.[16] Inventory control would be a moot point if there are no constraints facing business managers, i.e. warehouse storage space, limits on funds, cost minimization, profit maximization, etc. A manager would simply hold 100% of all items all the time regardless of any costs incurred or usage for the items, but business reality dictates that this is not the case. The constant challenge facing managers is arriving at an optimal inventory level within the bounds of myriad constraints - keeping the right stocks, at the appropriate levels, at the appropriate time while minimizing costs. It is assumed that some kind of an inventory records system is used to track on-hand quantities, usage, costs, replenishment orders, locator system, etc. of each individual item held in stock. There are some fundamental terms that one must become familiar with when discussing inventory control policies:

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[14] Silver, E.A., Pyke, D.F., and Peterson, R., *Inventory Management and Production Planning and Scheduling,* p. 235

[15] Waters, C.D.J., *Inventory Control and Management*, p. 4

[16] Brown, R.G., *Materials Management Systems*, p. 245

1. High and Low Limits

The concept of setting high and low limit quantities to inventory is not uncommon in inventory control systems. The idea is predicated on the notion of constraint resources. Succinctly, it is neither efficient nor effective for any organization to hold huge amounts of inventory, thus, logistics inventory managers must determine and set the maximum level of inventory to hold that would achieve both efficiency and effectiveness while staying within the bounds of the organization's constraints. High limit, also known as the requisitioning objective (RO), is the maximum quantities of material required to be maintained on hand and on order to sustain operations. It is derived by adding the Lead-time demand, safety level, and the order size.[17] Figure 3 below illustrates the RO formula:

Figure 3. Requisitioning Objective

$$\boxed{\text{RO} = \text{Lead-time Demand} + \text{Safety Level} + \text{Order Size}}$$

Conversely, low limit is the stock position that signals the need to start a replenishment action. Low limit is also referred to as the reorder point (RP). It includes the stock's safety level plus the Lead-time demand as shown in Figure 4.

Figure 4. Reorder Point

$$\boxed{\text{RP} = \text{Lead-time Demand} + \text{Safety Level}}$$

2. Operating Level

Operating level is the quantity of material required to be on-hand and available to support and sustain operations during the period between replenishments.

[17] http://www.dtic.mil/doctrine/jel/doddict/data/r/04549.html (last accessed: 28Oct2005)

3. Safety Level

The stock's safety level serves as a buffer against spikes in demand or against possible delays in the receipt of a replenishment action. The safety level represents the quantity of material required to be on-hand to permit continual operations in case of demand or replenishment fluctuations after placing an order.

4. Economic Order Quantity

When the quantity of a stock material reaches its low limit or reorder point, it indicates to the inventory managers that it is time to order more of that stock. This is one of the determinants of when to order more materials for stock. The 'how much or how many' to order is another factor. If high limits are set and fixed for that stock item, then inventory managers would merely procure the quantity required to get back up to its high limit, however, this system might not be cost efficient for multiple items that reach their reorder points at different time intervals. This system would entail placement of orders at different times, therefore incurring ordering costs each time the order is placed to suppliers.

5. Order and Shipping Time or Procurement Lead Time

Order and Shipping Time (OST) is simply the interval between the moment that an order for a material is placed and its receipt by the organization for use. OST, also called procurement lead time, is a variable that organizations may have little control over, but nonetheless, it is an essential component of inventory control. OST can be estimated based on industry standards or freight guarantees and may be negotiable between an organization, the freight agency, and its supplier. Inventory control organizations must factor in the OST estimate when calculating their reorder points to preclude stock outs.

C. A-B-C ANALYSIS INVENTORY CLASSIFICATION SYSTEM

The closest commercial industry equivalent to the Navy's SIM inventory system that the project authors can surmise is the A-B-C classification system. The system rank organizes or categorizes the company's inventory according to material price, sales, frequency of usage, contribution to profitability, etc., or any combination of factors as determined by management policy. In other words, inventory items are segregated into categories according to their importance to the firm. To illustrate, the top 20% or 30% of a company's inventory may be classified into the 'A' inventory group based on a set criteria as determined by management. This group demands the highest managerial focus and may require constant and regular attention to ensure it never runs out and is never stocked in excess of its need. The bottom 30% or 40% of inventory are the least costly or least used, etc. class of materials and are categorized as 'C' class materials. Excess inventory of these materials has limited impact on overall profitability, so they are ordered infrequently through large orders. The remaining inventory that fall in between the 'A' and 'C' classes are classified as the 'B' group. The 'B' class materials do not require as much individual attention as the 'A' group, so they are managed using automated ordering processes.

The idea behind the A-B-C classification system is to assist managers to focus management attention on a smaller number of items in the 'A' category that may account for the highest proportion of sales, turnover, usage, margin, etc. "It is often said that the top 20% of items – [i.e.] the 'A' items' – account for 80% of inventory value."[18] The A-B-C inventory classification aids managers to prioritize and focus their efforts on a smaller number of inventory that are considered absolutely critical to the business. Table 5 shows some examples of how an A-B-C inventory control policy might look. It must be pointed out that the table is not all inclusive, and management may certainly modify and tailor their criteria and management practices to suit the company, the industry, and the processes.

The A-B-C system may be used in conjunction with or in addition to the Fast, Medium, Slow (FMS) movement classification. For instance, if the A grouping was derived using the highest price criterion, it may then be further subdivided into Fast, Medium, Slow moving subcategories.

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[18] Dear, A., *Inventory Management Demystified*, p. 231

This classification system applies well to dependent demand systems where current and future requirements are dependent upon production plans or are easily known. However, A-B-C inventory classification may also be applicable to independent demand systems if there are sufficient historical data to calculate usage, price, etc.

Table 5. A-B-C Inventory Control Requirements[19]

CHARACTERISTICS	POLICY	METHODS
A items • Few items • Most turnover • High usage • Most money value	• Tight control • Personal supervision • Communication/reporting	• Frequent monitoring • Accurate records • Sophisticated forecasting • Service level policy
B items • Important items • Significant turnover	• Lean stock policy • Use classic stock control • Fast appraisal methods • Manage by exception	• Sophisticated system • Calculated safety stocks • Limit order value • Computerized management information system & exception reporting
C items • Many items • Low turnover • Low usage • Low value items	• Minimum supervision • Supply to order where possible • Large orders • Zero or high safety stock policy	• Simple system • Avoid stock outs and excess • Infrequent ordering • Automatic system

D. JUST IN TIME AND ZERO INVENTORY

Just-In-Time (JIT) inventory is a relatively new concept in industry and one that the Navy is trying to adapt to some degree in selected stable demand organizations. The principle is simply that the item is available when needed and none are held in stock when not required. The underlying motivation is the fact that holding and sitting

[19] Wild, T., *Best Practice in Inventory Management*, p. 33

inventory incurs costs to the company; hence if there is a method that would provide parts or supply just when they are needed, then inventory would not be required to be maintained. The concept sounds very simplistic and upon cursory examination may seem attractive, but a deeper investigation reveals that JIT system might not be ideal for implementation in highly complex operations with high demand variability and unpredictability. If implemented successfully, JIT can bring considerable benefits to an organization: the elimination, or at least minimization, of stock can alone bring substantial savings.[20] However, JIT is dependent on ideal operational environments hence, can only be used in particular types of organizations. A successful JIT system relies on a relatively stable and predictable demand where requirements are well known, easily forecasted with very high accuracy, dependent on stable and reliable suppliers, and must have a robust transportation or co-located supply sources, freight, and delivery infrastructure. At present, the most successful users of JIT are car-assembly plants, such as Toyota of Japan, which make large numbers of almost identical products. It is easy to deduce that JIT would not work well in the fast paced, dynamic, and unpredictable environment of shipboard logistics.

Closely related to the JIT method of inventory is Kanban. Kanban is taken from the Japanese and can be literally translated to mean "card".[21] Kanban is an operational method, consisting simply of a ticket or a Kanban card that triggers a pull system from within other parts of the company or from a supplier.[22] The Kanban card signals a cycle of replenishment for production and materials. It maintains an orderly and efficient flow of materials throughout the entire manufacturing or production process. The ticket can simply be a printed card that contains specific part information, i.e. part number, quantity, description, nomenclature, etc. The trigger devise is not restricted to a ticket or card. Other signal mechanisms can be used, i.e., colored lights or sounds in the production floor. A rudimentary analogy can be made to the way a burger fastfood chain assembles an order: a ticket is printed in the kitchen when a customer orders at the counter, the

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[20] Waters, C.D.J., *Inventory Control and Management*, p. 301

[21] Wild, T., *Best Practice in Inventory Management*, p. 67

[22] Ibid.

cook makes and places the burger on a tray and passes the tray on to the fryer, French fries are then added to the order, and the entire tray is passed on to the soda dispenser where a cola is added and delivered to the waiting customer. As one can surmise, the Kanban system also relies on a very stable production process. Needless to say, not unlike JIT, this type of an inventory system is not so appropriate to a shipboard operation.

E. MATERIAL REQUIREMENTS PLANNING

Material Requirements Planning (MRP) is an inventory technique for a dependent demand system utilizing backward scheduling usually practiced in manufacturing. The MRP process simply takes the delivery date that the end product is required, then works back the manufacturing process to figure out when its components are required to produce the good. "Offsetting by the lead time" is often the jargon used for this method.[23] Moving back by the process lead time gives the time to start on the order. This should happen just as the supplies are delivered. Going back further by the supply time identifies when to place the purchase order. With dependent demand, the size and timing of the requirements are known for the next level. This system implies that a Master Production Schedule (MPS) must be utilized in order for it to work. MRP therefore provides production and inventory managers with good inventory control. It enables parts to be scheduled for the day that they are required. There are two main attributes of MRP: time phasing and structure. One can see that MRP works best in a very stable demand environment where the process structure and time requirements are well established and lead time is relatively long. Although, MRP systems are being applied in a wide variety of stocking situations outside manufacturing, it seems apparent that this type of system might not work well in the unpredictable environment of shipboard operations.

Related to MRP inventory control method is the Bill of Materials (BOM). A Bill of Materials (BOM) is simply the list of parts or materials, or ingredients so to speak, needed to produce an end-item. Classic stock control deals with individual items

[23] Wild, T., *Best Practice In Inventory Management*, p. 178

independent of all others.[24] However, for most inventory the usage of one item is usually linked to that of others. BOM takes this inter-relational link into consideration. It takes an end-item in its entirety and breaks it down into all its components and sub-components. Hence, for every end-item being manufactured, inventory control personnel know precisely what type of components and how many of each type are needed and at exactly which point in the production line those piece parts are required. Inventory control and management would be a lot simpler with the knowledge of these stable elements: what's needed, when it is needed, and in what quantity. It can be easily inferred that BOM also applies well to a dependent demand system but might not be very appropriate for application to the dynamic unstable demand of a shipboard operation.

F. DEMAND FORECASTING

A persistent challenge to all inventory managers is how to forecast demand accurately. Inventory requirement is a bit easier to forecast in dependent demand systems, if inventory decisions are based solely on stable production. Demand forecasting has been the subject of many studies of independent demand systems where future demand requirements are unpredictable and variable. Generally, forecasting is defined as a scientific process of estimating future requirements by analyzing the trends and patterns of historical data[25] and other factors that may affect future demand of materials. Estimates of future requirements are essential in order to plan for the level of activity to be expected while enabling business managers to budget, allocate, or procure the appropriate resources necessary to fulfill that level of activity. The premise of forecasting assumes that characteristic trends identified in historical data or other variables used to forecast requirements will continue into the future. The process relies heavily on statistical analysis and objectivity of data without consideration for subjective variables that may or may not affect the future outcome of an event. Holding all factors constant, statistical forecasting could be dependable, unfortunately, this is not the always the case. Forecasters must take into consideration extraneous factors that could affect the

24 Wild, T., *Best Practice In Inventory Management*, p. 182

25 Lewis, C.D., *Demand Forecasting and Inventory Control*, p. 5

forecast: i.e., an impending labor strike at a supplier's facility will impact timely delivery of materials ordered from that supplier, or an economic downturn may impact sales of consumer merchandise. There are several techniques and mathematical models that companies can employ in forecasting future inventory needs.

1. Time Series Forecasting Models

Time series analysis is a large class of methods for developing forecasts using historical demand data.[26] Table 6 shows an example of types of forecasting based on time periods. It must be noted here that the time periods in Table 6 may vary depending on industry standards and accepted practices or on management's strategic and operational business perspectives.

Table 6. Types of forecasting based on time[27]

Forecast Type	**Time period**	**Example of application**	**ForecastingTechnique**
Immediate-term	¼ hr to 1 day	Electricity demand	Various
Short-term	1 wk to 1 month	Demand forecasting in industry and commerce	Exponentially weighted averages and derivatives
Medium-term	1 mo to 1 yr	Sales and financial forecasting	Regression, curve fitting, time-series and causal models
Long-term	1 yr to 1 decade	Technological forecasting	DELPHI, think tanks, consumer panels

It is worthwhile to reiterate that this forecasting technique is based on the analysis of past patterns of demand, a discipline known as 'time-series analysis.'[28] The assumption in any mathematical forecasting technique is that the factors influencing the

[26] Shapiro, J.F., *Modeling the Supply Chain,* p. 21

[27] Lewis, C.D., *Demand Forecasting and Inventory Control*, p. 6

[28] Dear, A., *Inventory Management Demystified*, p. 40

observed pattern will continue to be influential in the future. The time-series analysis approach to forecasting generally recognizes four fundamental demand patterns:[29]

1.) Trending demand pattern which can indicate either a positive or a negative trend line,

2.) Seasonal pattern where demand is affected by the yearly (periodic) seasons or by other recurring events that exhibit characteristics of seasonality,

3.) Cyclic pattern has similarities to seasonal pattern where demand exhibits cyclical trend that can be attributed to a business cycle or an expected life cycle of an industry, and lastly

4.) Random demand, which as the term implies, is a default category for all causes of variations that cannot be ascribed to trend, seasonality, or cycle patterns.

Time series models use exponential smoothing, moving averages, and other more sophisticated models that relate one or more dependent demand variables at a particular point in time to the values of independent demand variables at past points in time.[30]

2. Causal Forecasting Models

Unlike time series models, causal models do not assume trends in demand. The model presupposes that there are other variables or reasons behind the demand for materials, other than historical data patterns. For example, hotel managers in Monterey notice that hotel occupancy increased whenever PGA golfing events are held at Pebble Beach Golf Links, and demand for rooms increased even more when Tiger Woods was playing in the tour. Demand for rooms increased because of the influx of tourists drawn by the golf tournament and the celebrity status of Tiger Woods which would not lend itself to a historical trend. A forecast model can be created to incorporate the effect of

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[29] Dear, A., *Inventory Management Demystified*, pp. 40-41

[30] Shapiro, J.F., *Modeling the Supply Chain,* p. 258

these variables on the demand for rooms. Causal models use statistical regression methods to relate dependent demand variables in the future to independent variables at earlier points in time, but also include other variables whose values are believed to affect demand.[31]

3. Other Forecasting Models

The aim of statistical models is to try to establish and correlate the relationship between demand and the factors affecting the pattern, i.e., the seasons, to produce forecasts. Demand analyses and inventory forecasting techniques are varied and the field of mathematical modeling too broad to adequately cover in this report. It is sufficient to point out that scientific and statistical forecasting models proliferate in industry, and that there are several methods of reducing the guess work in estimating future inventory requirements.

G. SPARE PARTS INVENTORY

The advances in technology and the increasing sophistication of plant machinery and equipment (or weapon systems for that matter) draw attention to the importance of holding spare parts inventory. Spare part inventory are bit and piece parts or material components of equipment, machinery, or any mechanical, electrical, or electronic systems held in stock against the possibility of system failure requiring replacement of material components to repair the failed system. Although manufacturers of machinery, equipment, and gadgets have managed to produce high-quality and highly reliable end products, there is no absolute guarantee against system failures and equipment breakdowns. There are a myriad of factors that can lead to product breakdowns:[32]

1.) a poor quality component or part,

2.) misuse or abuse of system or its component parts,

[31] Shapiro, J.F., *Modeling the Supply Chain*, p. 259

[32] Petrovic, R., Senborn, A., and Vujosevic, M., *Hierarchical Spare Parts Inventory Systems*, p. 32

3.) poor or improper preventive maintenance,

4.) environmental factors, such as water leaking into an electronic system or electrical surges caused by lightning strikes, or

5.) a combination of these factors.

Whatever the reason for the failure, product (system or equipment) availability, and the time needed to repair the breakdown are of utmost importance to a business organization. A manufacturing business may literally lose millions of dollars if one of their production lines remains shut down for a long period of time because of failed critical equipment. Businesses minimize this downtime by maintaining an effective spare parts inventory. This assumes, of course, that a capable technician is available and is able to repair the failure.

The management and control of spare parts inventory must consider the following characteristics: [33]

1.) stochastic and deterministic demand processes,

2.) the existence of recoverable (or repairable) items, and

3.) complex multi-level inventory structures.

Demand for spares is mostly generated by degradation or failures of end-products or equipment requiring parts replacement. Therefore, the demand for spares is inherently stochastic.[34] However, there are also demands that are generated from periodic and preventive maintenance actions that can be estimated by a deterministic function.[35]

The existence of repairable items among spare parts is a particular aspect of spare parts inventory that differs from other types of inventory. Essentially, recoverable items are those components whose nature and cost make them more economical to repair than to discard. When such items fail in the equipment, spares are obtained from stock to replace these items, and the failed item itself is repaired to its functional condition and

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[33] Petrovic, R., Senborn, A., and Vujosevic, M., *Hierarchical Spare Parts Inventory Systems*, p.11

[34] Ibid., p.32

[35] Ibid., p.12

returned back to stock. The management and control of recoverable items is a little more complicated problem than that of non-repairable or consumable items. The repair process of the failed repairable item adds a new dimension to spare parts inventory control.[36]

Diversity of system structures is another specific property of inventory involving spare parts. Multipoint stocking, such as multilevel-structured systems, is encountered more often in spare parts inventory. An important characteristic of this inventory system is that only some of the stocking points are under external demand only. The processes of resupply/replenishment of spares differ to a great extent from other types of inventory.[37] Following the same concepts of DLR and Non-DLR items on Navy ships, an important classification of items in spare parts inventory is their classification into:[38]

1.) repairables

2.) consumables

Similar to any commercial business's spare parts inventory, the repair parts inventory aboard US Navy surface ships follow much of the same principles and processes mentioned in this section.

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36 Petrovic, R., Senborn, A., and Vujosevic, M., *Hierarchical Spare Parts Inventory Systems,* p. 12

37 Ibid., p.12

38 Ibid., p.13

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V. COMPARISON OF SHIPBOARD AND COMMERCIAL INVENTORY CHALLENGES

A. MISSION FOCUS AND OPERATIONAL ENVIRONMENT

One might argue that inventory is inventory no matter what business or industry the organization is in. However, US Navy surface ships are called upon to operate under unique conditions. First and foremost, US Navy ships are warships and as such are a highly mobile instrument for national policy, and if need be, for war and combat. Some people might dispute mobility as a significant difference, citing commercial airliners and cruise ships as examples of mobile platforms, nevertheless, the authors would assert that private vessels have established destinations with logistical support infrastructure in close proximity. The goals of inventory managers in the private sector and SUPPOs aboard US Navy surface ships are not dissimilar – both strive to maintain adequate spare parts inventory for immediate availability and use, hence ensuring high equipment or system availability for the operators. However, businesses support static systems and plants operated within certain parameters, while ships' systems and equipment are at times pushed to the edge of their operating limits to meet operational and mission requirements. In the commercial world, business profits drive the company, whereas, the mission and operational requirements are the paramount focus aboard US warships. Industry managers are more conscious about minimizing costs to maximize profit. Although shipboard managers take into account budgetary constraints, operational availability and mission accomplishment are their bottom line. While SUPPOs are required to adhere to their operating budgets, they can always ask for more when combat capability is jeopardized.

B. DYNAMIC ENVIRONMENT AND DEPLOYMENTS

Needless to say, US Navy ships ply the seas and are deployed all over the world. This is a huge differentiating factor between commercial and shipboard environments, and a constant challenge to SUPPOs in managing and timing their replenishment actions. Computed and estimated OSTs can be thrown off with shifting operational schedules, and the need for operational security restricts SUPPOs from sharing ships schedules with the supporting shore logistics infrastructure for planning purposes. Commercial inventory managers do not operate under these conditions.

C. MANAGEMENT ATTENTION/COMPETING PRIORITIES

Spare parts inventory management is not the only responsibility and duty that SUPPOs aboard ships are expected to perform. There are several other duties that may compete for their management attention or at times conflict with their managerial functions. SUPPOs aboard US surface ships are also ultimately responsible for food services, laundry services, disbursing services, postal services, etc. aside from their stock control duties. There are also military duties and collateral requirements placed on SUPPOs that, albeit not primary functions, nonetheless are important to the overall mission efficiency and effectiveness of the ship, e.g. Damage Control Training, military watches, etc.

D. HYBRID DEMAND SYSTEM

Inventory control managers must also take into account the unique demand environment aboard naval surface ships when comparing commercial and shipboard inventory management. Unlike most commercial entities, demand for spare parts onboard ships is a hybrid mix of dependent and independent demand systems, most especially in SIM inventory. A portion of SIM inventory might have very predictable, even stable, demand patterns. As noted in Chapter II, ships routinely perform periodic preventive maintenance on machinery, equipment, and onboard weapon systems. Scheduling and tracking these routine maintenance actions are coordinated and conducted through the ship's 3-M system. Theoretically, at any point in time, shipboard inventory control managers should be able to forecast what the demand and usage in the future will be for a particular repair part by looking at the maintenance schedule and then take those maintenance actions requiring routine replacement of parts or materials. For example, a quarterly periodic preventive maintenance action of an air conditioning system may require changing air filters. It should then be a simple calculation to project what the requirement would be for the air filters on a semi-annual or even an annual basis. However, the same air filters might also have some independent demand elements. For example, an unscheduled equipment breakdown of an air conditioning system might also necessitate a replacement of the air filters in order to complete repairs of the system.

It should be noted here that the US Navy does not have a system yet that fully integrates maintenance and inventory data; a system that is able to cull out these periodic material requirements from 3-M/MDS records and forecast these requirements.

E. DE-EMPHASIZED RELATED INVENTORY COSTS

Recall that one of the three elements of inventory control is cost. Commercial supply managers understand that holding stocks entails that the organization incurs costs related to carrying these inventory, such as, holding costs, ordering costs, transportation costs, and other indirect costs attributable to inventory. Since the primary motivation of private business entities is profit, ergo, they are driven to minimize costs while attempting to maximize profits. Commercial organizations must always be mindful to account for their costs in order to better control them. SUPPOs aboard US Navy ships do not have the same hard funding constraint in controlling costs when managing their inventory. The primary focus for SUPPOs is to satisfy the ship's mission requirements. Even though a ship's OPTAR funds are not unlimited, CNSP's policy direction to all its SUPPOs, indeed one of its goals, is for their ships to maintain 100% on-hand plus on order of all carried spare parts, especially for SIM items. Thus, SUPPOs can submit their reorders as often as they want without regard for EOQs, ordering costs, nor transportation costs. As a matter of fact, ships that reorder more frequently and conscientiously adhere to the 100% on-hand plus on order policy tend to have better issue effectiveness rates. Associated replenishment cost becomes a secondary concern. The constraining factor that prevents SUPPOs from ordering large quantities of every item in the inventory to guarantee 100% material availability is the established allowance limits.

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VI. SUPPLY MANAGEMENT CORRELATIONS

A. METHODOLOGY

The focus of this project is SIM effectiveness and management techniques that affect this effectiveness. Supply management techniques of shipboard personnel are observed to determine if there are any correlations between these techniques and SIM effectiveness. Quantifiable management practices were identified, measured and compared to SIM effectiveness to identify linear relationships among these management procedures.

The most common measure of correlation is the Pearson Product Moment Correlation, called Pearson's correlation for short. Pearson correlation is a method to determine whether any linear relationship exists between two variables. The correlation between two variables reflects the degree to which the variables are related and it is measured with a correlation coefficient. The coefficients range from +1 to -1. A correlation coefficient of +1 means that there is a perfect positive linear relationship between two variables.[39] The correlation coefficient can be used to test for a relationship between two variables.

Supply management techniques were categorized into three groups based on how they were expected to affect SIM effectiveness:

Category 1 - Those tasks that would be expected to improve SIM effectiveness by improving inventory management skills

Category 2 - Those tasks that would be expected to worsen SIM effectiveness because these tasks would compete for time and/or other resources that could otherwise be devoted to SIM management

Category 3 - Those tasks that directly or indirectly encourage concentration on SIM management and would thus be expected to improve SIM effectiveness

The authors contend that these variables, i.e., measures of time spent on supply management practices, impact SIM effectiveness. They test their theory using the t-test. The null hypothesis, annotated H_o, asserts that there is no relationship between supply management practices and SIM effectiveness. On the other hand, the alternative hypothesis, denoted by H_1, maintains that time spent on supply management techniques does affect SIM effectiveness either in a beneficial or adverse manner.

A twelve-question survey was sent to SUPPOs of surface ships to gauge their management practices. Appendix A is a sample questionnaire while Appendix B shows responses to the survey in tabular format. The authors focused on the following specific supply management areas:

1.) Stock Control

2.) DLR Management

3.) SIM/DBI Management

4.) Financial Management

5.) COSAL Management

6.) Reorder Reviews

7.) CMP Monitoring

8.) SUPPO's Priorities

9.) SUPPO's Perception of CO's Priorities

10.) SUPPO Level of Knowledge

11.) Supply Personnel Level of Knowledge

The project utilized the Pearson Correlation function of Microsoft Excel® to calculate the correlation coefficient between the survey values and the ship's SIM effectiveness rates to determine if any correlation existed and the direction of the correlation if it did exist. A point-biserial correlation was used for situations where one

[39] Lane, D.M., Hyperstat Online, *Pearson's Correlation Coefficient.*, http://davidmlane.com/hyperstat/A34739.html (last accessed: 17Sep2005)

of the variables was binary. The formula is the same for the Pearson and point-biserial correlation coefficients.

The nature of this work is exploratory, as the authors are conducting preliminary research on the effect that time spent on specific supply management practices had on SIM effectiveness. The aim is to identify possible correlations and it is not intended to establish higher levels of certainty that would require additional time, fiscal and personnel resources. Because of the nature of this work, the sample size is relatively small at 12 to 14 participants in the survey.

The significance level was set at 10% which means that the null hypothesis will be rejected only if there is a 10% chance that there is no linear relationship between the two variables. For the scope of this project, a 10% significance level is acceptable.

B. CORRELATION ANALYSIS RESULTS

1. Stock Control Management

SIM management is a subset of stock control management. Stock control management involves managing reorder reviews, inventory quantities and location accuracy. Because this management practice generally aligns with SIM management, time spent managing stock control operations is expected to have a positive correlation with SIM effectiveness.

Stock control management practices are included in category 1, as more time spent in stock control management should improve SIM effectiveness. The survey asked the respondents to indicate how much time they spent on stock management. The response options were less than five hours per week, six to 10 hours per week, 10 to 15 hours per week, and more than 16 hours per week. The range of each response option was averaged, and the value was correlated with the net SIM effectiveness for the respondent's command. A respondent who chose less than 5 hours per week received a value of three; those who chose six to 10 hours per week received a value of eight, and so on with values of 12 and 18 assigned.

H_o: Time spent managing stock control operation has no effect on SIM effectiveness.

H_1: Time spent managing stock control operation has a positive correlation with SIM effectiveness.

Table 7. Stock Control

Correlation		
net eff and q1		
Pearson Coefficient of Correlation		0.3734
t Stat		1.5059
Df		14
P(T<=t) one tail		0.0772

A Pearson correlation shows a positive relationship between stock control operations and SIM effectiveness and this value is different from zero at the 10% threshold for a one-tailed t-test. Thus there is sufficient evidence to support the alternative hypothesis.

As stated earlier, a relationship exists between stock control practices and SIM effectiveness with items such as reorder reviews ensuring that parts are on the shelf when needed. Additionally, quantity and location validations in stock control practices increase the probability that parts will be readily available as SIM demands are generated. If either reorder reviews or quantity and location validation are not accomplished, the SIM inventory will suffer because empty spots will not be filled or parts may be misplaced when a demand occurs. Both situations distract from SIM effectiveness.

2. DLR Inventory Management

DLR management is a critical area of supply operations. This practice focuses both time and energy on expensive repair parts as they move throughout the supply system to ensure that they are not lost. Because of the enormous costs of DLR items, this program demands immense attention from supply personnel. Efforts spent managing

DLR inventory draw resources away from SIM management. The two management practices compete for personnel attention and time.

DLR management practices are included in category 2, as more time spent in DLR management should deteriorate SIM effectiveness. The survey asked the respondents to indicate how much time they spent on DLR management. The responses were assigned a value of three, eight, 12 or 18 similarly to the stock control section and were correlated with the respondent's SIM effectiveness.

H_o: There is no relationship between DLR inventory management and SIM effectiveness.

H_1: Time spent managing DLR inventory should have a negative correlation with SIM effectiveness.

A Pearson correlation indicates a positive relationship between DLR inventory management and SIM effectiveness; however, the p-value is greater than the 10% threshold for a one-tailed t-test, and the null hypothesis can not be rejected. Since DLR management pulls resources away from SIM management a negative correlation was expected. The alternative hypothesis was not supported by the data.

Table 8. DLR Inventory Management

Correlation		
net eff and q2		
Pearson Coefficient of Correlation		0.2597
t Stat		1.0064
df		14
P(T<=t) one tail		0.1657

3. SIM/DBI Management

Time spent managing SIM/DBI should have a positive correlation with SIM effectiveness. SIM management requires time and resources to achieve the desirable effectiveness goals. Without this dedication of time and resources, the program will fail. Generally speaking, programs that receive more attention will tend to do better.

SIM/DBI management practices are included in category 1, as more time spent in SIM/DBI management should improve SIM effectiveness. The survey asked the respondents to indicate how much time they spent on SIM/DBI management. The responses were assigned a value of three, eight, 12 or 18 similarly to the stock control section and were correlated with the respondent's SIM effectiveness.

H_o: There is no relationship between SIM/DBI management and SIM effectiveness.

H_1: Time spent managing SIM/DBI should have a positive correlation with SIM effectiveness.

SIM/DBI management accomplishes the tasks deemed required to achieve greater SIM effectiveness, and therefore a positive correlation was expected between SIM/DBI management and SIM effectiveness. A Pearson correlation was not calculated as there was no variation in responses. All respondents indicated that they spend less than 5 hours per week managing COSAL issues.

4. Financial Management

Like DLR management, financial management requires a great deal of time and personnel resources to accomplish effectively. SUPPOs are taught throughout their careers the seriousness of financial management and the possible criminal punishment associated with financial mismanagement. However, financial management provides little or no value added to SIM management. The time spent managing financial affairs should have a negative correlation with SIM effectiveness.

Financial management practices are included in category 2, as more time spent in financial management should deteriorate SIM effectiveness. The survey asked the respondents to indicate how much time they spent on financial management. The responses were assigned a value of three, eight, 12 or 18 similarly to the stock control section and were correlated with the respondent's SIM effectiveness.

H_o: There is no relationship between financial management and SIM effectiveness.

H_1: Time spent managing financial affairs should have a negative correlation with SIM effectiveness.

Table 9. Financial Management

Correlation		
net eff and q4		
Pearson Coefficient of Correlation		0.3242
t Stat		1.2823
df		14
P(T<=t) one tail		0.1103

A Pearson correlation shows a positive relationship between financial management and SIM effectiveness but it is not significant at the 10% level for a one-tail test. Thus the result of the analysis does not support the alternative hypothesis.

A positive correlation was not expected since financial management pulls resources away from SIM management. The relationship between financial management and SIM effectiveness is a strong candidate for follow on study to gather more information about the relationship between the two variables.

5. COSAL Management

COSAL management competes with SIM management for both time and shipboard personnel resources from both supply and information technology divisions. Furthermore, COSAL management does not lend any value to SIM management in the fashion than stock control management does. Because of the competition for time and resources between COSAL and SIM management with little or no value added, the time spent managing COSAL should have a negative correlation with SIM effectiveness.

COSAL management practices are included in category 2, as more time spent in COSAL management should deteriorate SIM effectiveness. The survey asked the respondents to indicate how much time they spent on stock management. The responses were assigned values in the same manner as above.

H_o: There is no relationship between COSAL management and SIM effectiveness.

H_1: Time spent managing COSAL should have a negative correlation with SIM effectiveness.

A negative correlation was expected to exist between COSAL management and SIM effectiveness because COSAL management pulls resources from SIM management practices. A Pearson correlation was not calculated as there was no variation in responses. All respondents indicated that they spend less than 5 hours per week managing COSAL issues.

6. CMP Monitoring

Continuous monitoring by shipboard and higher echelon personnel focuses time and personnel resources on SIM effectiveness. SIM effectiveness is one of the metrics reviewed in the CMP program where the TYCOM and shipboard personnel have access to determine how well they are doing. Once this SIM performance measure is captured, the appropriate personnel can take actions to address any problems as they occur. There is a direct link between SIM effectiveness measurements and CMP. Time spent managing/monitoring CMP reports should have a positive correlation with SIM effectiveness.

CMP management/monitoring practices are included in category 1, as more time spent managing/monitoring CMP should improve SIM effectiveness. The survey asked the respondents to indicate how much time they spent on CMP management. The responses were assigned a value of three, eight, 12 or 18 similarly to the stock control section and were correlated with the respondent's SIM effectiveness.

H_o: There is no relationship between CMP managing/monitoring and SIM effectiveness.

H_1: Time spent managing/monitoring CMP reports should have a positive correlation with SIM effectiveness.

Table 10. CMP Monitoring

Correlation			
net eff and q7			
Pearson Coefficient of Correlation			-0.0548
t Stat			-0.2052
df			14
P(T<=t) one tail			0.4202

CMP monitoring and SIM effectiveness were expected to have a positive correlation because the general consent is that things that are monitored normally perform better. A Pearson correlation indicates an unexpected negative relationship between CMP monitoring and SIM effectiveness. The p-value is more than the 10% threshold for a one-tailed test, the coefficient is in the "wrong" tail of the distribution, and the null hypothesis can not be rejected in favor of the alternative hypothesis. This phenomenon can perhaps best be explained by the notion that supply personnel may be in a reactive mode. If more attention is spent on CMP monitoring because the CMP reported poor SIM effectiveness, this correlation would be expected.

7. SUPPO's Priorities

To achieve desirable SIM effectiveness, supply personnel must invest time and effort. The SUPPO is the department head for the supply department, charged with effectively leading the supply department to accomplish various management functions with SIM effectiveness being one of them. The SUPPO has the authority to direct supply resources towards areas of the operation to achieve best results. However, the SUPPO does not have unlimited resources at his disposal, so he has to prioritize his resources to deal with areas that he feels are most important and/or need the most attention. SIM management is competing with other management practices. But as stated above, those areas which receive the most attention are believed to do better. If this idea holds for the amount of attention that is given to SIM management, then SUPPOs who place a high priority on SIM managing should have a positive correlation with SIM effectiveness.

SUPPOs priority of managing SIM inventory to maintain 100% on-hand or on order was included in category 3, as more priority is given to SIM effectiveness rate management should improve SIM effectiveness. The survey asked the respondents to prioritize various supply management requirements starting with 1 being the most important, 2 being the second most important, and so on. SUPPOs did not rank all selections, so only the top three were selected from the rankings of each SUPPO. If the item fell in the top three, it was classified as important and given a score of 1. If an item did not fall in the top three, it was classified as less important and given a score of 0.

H_o: There is no relationship between SIM management practice of maintaining 100% on-hand or on order as a SUPPOs priority and SIM effectiveness.

H_1: SUPPOs who place a high priority on maintaining SIM inventory at 100% on-hand or on order should have a positive correlation with SIM effectiveness.

Table 11. SUPPO's Priorities (100% OH + On Order)

Correlation		
Net Eff and q8.3		
Coefficient of Correlation		0.0124
t Stat		0.0465
df		14
P(T<=t) one tail		0.4818

A positive correlation was expected to exist between SUPPOs who placed higher priorities on maintaining 100% SIM inventory on-hand or on order and actual SIM effectiveness. The reason behind this expectation was that the SUPPO would dedicate the necessary efforts and resources to maintain adequate SIM stock levels and achieve adequate stock levels and desirable SIM effectiveness. A point biserial correlation indicates a positive relationship between SUPPO's priorities on SIM management and effectiveness. However, the significance level does not meet the 10% threshold. The result of the analysis does not support the alternative hypothesis.

A second SIM management priority was measured to determine if any correlation existed with SIM effectiveness. The SUPPOs priorities of managing SIM effectiveness rates on the CMP was included in category 3, as the survey asked the respondents to prioritize various supply management requirements starting with 1 being the most important, 2 being the second most important, and so on. SUPPOs did not rank all selections, so only the top three were selected from the rankings of each SUPPO. If the item fell in the top three, it was classified as important and given a score of 1. If an item did not fall in the top three, it was classified as less important and given a score of 0.

H_o: There is no relationship between having SIM effective rates as a SUPPOs priority and SIM effectiveness.

H_1: SUPPOs who place a high priority on maintaining acceptable SIM effectiveness rates should have a positive correlation with SIM effectiveness.

Table 12. SUPPO's Priorities (Effectiveness rate)

Correlation		
net eff and q8.6		
Coefficient of Correlation		-0.3858
t Stat		-1.5079
df		13
P(T<=t) one tail		0.0777

A positive correlation was expected to exist between SUPPOs who placed higher priorities on SIM effectiveness rates and actual SIM effectiveness. There is an intuitive notion that when attention is given to an area to achieve a result, there is a greater chance that the objective will be achieved. According to this reasoning, a SUPPO who dedicates the necessary efforts and resources to achieve desirable effectiveness is more likely to achieve that effectiveness than one who does not exert the necessary effort. A point biserial correlation indicates a negative relationship between SUPPO's priorities on SIM effectiveness rates and actual SIM effectiveness rates. Again, the alternative hypothesis is not supported. This should only be true if the SUPPO or supply personnel are in a damage control mode, where they are placing more emphasis on SIM effectiveness rates to improve lower than desirable rates.

8. SUPPO's Perception of CO's Priorities

Commanding officers have a tremendous influence over the SUPPO. When a SUPPO is determining his priorities, he must determine the priorities of the commanding officer to ensure that they are consistent. Some may argue that the commanding officer's priorities are the SUPPO's priorities. If the commanding officer feels that SIM management is a top priority, SUPPOs are more likely to set SIM management as a priority and accomplish a higher level of SIM management. SUPPOs who feel that their Commanding Officers place a high priority on SIM managing should have a positive correlation with SIM effectiveness.

SUPPOs responses about their commanding officers' priorities are included in category 3, as more priority is given to SIM management should improve SIM effectiveness. The survey asked the respondents to describe their commanding officers' priorities concerning various supply management requirements starting with 1 being the most important, 2 being the second most important, and so on. SUPPOs did not respond to all selections, so only the top three were selected from the rankings of each SUPPO. If the item fell in the top three, it was classified as important and given a score of 1. If an item did not fall in the top three, it was classified as less important and given a score of 0. The point biserial correlation procedure in Microsoft Excel was used to correlate these values of 1 or 0 with SIM effectiveness to determine if any correlation existed and the direction of the correlation.

H_o: There is no relationship between SUPPOs perception of Commanding Officer's priority of SIM effectiveness of Commanding Officers.

H_1: SUPPOs who feel that their Commanding Officers place a high priority on SIM managing should have a positive correlation with SIM effectiveness.

Table 13. CO's Priorities

Correlation		
net eff and q9.7		
Coefficient of Correlation		0.2807
t Stat		1.0132
df		12
P(T<=t) one tail		0.1655

A point biserial correlation indicates a positive relationship between SUPPO's perception of commanding officer's on SIM management and SIM effectiveness; however, the significance level did not meet the 10% threshold. The results of the analysis do not support the alternative hypothesis at this level, although they do at the 17% level.

9. Reorder Practices

As stated above, reorder review is a critical management aspect for SIM effectiveness because if reorders are not accomplished when appropriate, the likelihood of not-in-stock (NIS) occurrences increases. These NIS occurrences are mathematically linked to SIM effectiveness. Because of the mathematical link and the likelihood of lower NIS occurrences where reorders are accomplished frequently, SUPPOs who reorder repair parts more frequently should have a positive correlation with SIM effectiveness.

Reordering of repair parts was framed with selection criteria one, as more frequent reorders are accomplished SIM effectiveness should increase. The survey asked the respondents to indicate how frequently they reordered repair parts. The available response options were daily, more than once a week, once a week, more than once a month, and once a month. The responses were assigned a value of 0.05 for responses of once a month, 0.10 for more than once a month, and 0.20 for once a week; all respondents fell within this range. The assigned values were correlated with the respondents SIM effectiveness to determine the Pearson coefficient.

H_o: There is no relationship between frequency of ordering parts and SIM effectiveness.

H_1: SUPPOs who reorder repair parts more frequently should have a positive correlation with SIM effectiveness.

A positive correlation was expected between more frequent reorder practices for the same reasons that were cited in the reorder review section. A Pearson correlation indicates a negative relationship between frequent reorder practices and SIM effectiveness; however, the p-value is outside the 10% threshold. The result of the analysis does not support the alternative hypothesis.

Table 14. Reorder Practices

Correlation		
net eff and q10		
Pearson Coefficient of Correlation		-0.2029
t Stat		-0.7753
df		14
P(T<=t) one tail		0.2255

10. SUPPO's Knowledge Level

In order for SUPPOs to effectively manage SIM effectiveness, they must understand how SIM effectiveness works. The concept of SIM effectiveness is straightforward – have the part on the shelf when needed. However, the methods to accomplish SIM effectiveness at desirable levels are taught at the various supply schools. If the SUPPO has a sound understanding of the methods required to accomplish SIM effectiveness, he is more likely to succeed in SIM management than an officer who does not understand SIM management.

Navy SUPPOs learn about SIM management methods at the Naval Supply Corps School in Athens, Georgia. The training that the school provides readies new SUPPOs to face the challenges of the shipboard supply operation. Because the knowledge of SIM effectiveness is so critical to accomplishing effective SIM management, SUPPOs who feel that they learned SIM management best in Supply School will have a positive correlation with SIM effectiveness.

Retention of SIM management training was included in category 3, as a higher retention should result in higher SIM effectiveness. The survey asked the respondents to rank the various aspects of their general supply training with SIM management being one of the choices. The responses were assigned an ordinal value from one to four, with four being the highest retention of information and one being the least.

H_o: There is no relationship between SUPPO self assessed SIM management knowledge levels and SIM effectiveness.

H_1: SUPPOs who feel that they learned SIM management best in Supply School will have a positive correlation with SIM effectiveness.

Table 15. SUPPO's Knowledge Level

Correlation		
net eff and q11.2		
Coefficient of Correlation		0.0531
t Stat		0.1681
df		10
P(T<=t) one tail		0.4349

Generally, SUPPOs who are more knowledgeable of SIM management practices are anticipated to do better at SIM management; therefore, a positive correlation was expected between SIM effectiveness and SUPPO's knowledge level of SIM management. A Pearson correlation indicates a positive relationship between SUPPO self-assessed SIM management knowledge level and SIM effectiveness; however, the level of significance does not meet the 10% threshold. The results of the analysis do not support the alternative hypothesis.

11. Supply Personnel Knowledge Level

SUPPOs depend heavily on their enlisted personnel to accomplish the various supply functions. Like the SUPPO, these enlisted personnel must be knowledgeable about SIM management in order to accomplish desirable levels of effectiveness. SUPPOs who feel that their enlisted folks are knowledgeable in SIM management will have a positive correlation with SIM effectiveness.

SUPPO's opinion about retention of SIM management training by his enlisted personnel was included in category 3, as a higher retention should result in higher SIM effectiveness. The survey asked the respondents to rank the various aspects of their general supply training with SIM management being one of the choices. The responses were assigned an ordinal value from 1 to 4, with 4 being the highest retention of information and 1 being the least.

H_o: There is no relationship between SUPPO assessed SIM management knowledge of supply personnel

H_1: SUPPOs who feel that their enlisted folks are knowledgeable in SIM management will have a positive correlation with SIM effectiveness.

Table 16. Supply Personnel Knowledge Level

Correlation		
net eff and q12.2		
Coefficient of Correlation		0.2014
t Stat		0.7122
df		12
P(T<=t) one taile		0.245

A positive correlation was expected between supply personnel knowledge responses and SIM effectiveness for the same reasons cited in the SUPPO knowledge level area. A Pearson correlation indicates a positive relationship between SUPPOs assessed SIM management knowledge level of enlisted personnel and SIM effectiveness; however, the level of significance does not meet the 10% threshold. The results of the analysis do not support the alternative hypothesis.

C. CONCLUSION

Several supply management practices were reviewed in this chapter to determine if they correlate positively or negatively with SIM effectiveness. Hypotheses were made at the onset of the project as to whether the management practice would have a negative or positive correlation, and these hypotheses were tested using a t-statistic.

The results of the correlation analysis were not as the authors expected, as strong correlations were not formed and were rarely significantly different from zero. Only one management practice, time spent managing stock control, was found to have a significantly positive correlation with inventory effectiveness as hypothesized. Because of the exploratory nature of the study, sample size was very limited. A larger sample should be used if these relationships are to be investigated further, and a larger sample could more easily be evaluated for normality. Even with the limited sample, the weak results were surprising. Coefficients were very small and often had a sign opposite to the hypothesized sign.

One reason why the correlation coefficient signs were different from the hypothesized signs may be that supply personnel are in a reactive mode. This idea brings into question behavioral practices that are too complicated to be evaluated with simple bivariate linear relationships. Additional research is necessary to identify relationships between behavioral practices and SIM effectiveness.

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VII. BUSINESS PROCESS REENGINEERING

A. CONCEPT DESCRIPTION

This chapter looks at Business Process Reengineering (BPR) and its application with regards to SIM techniques. BPR is defined as "the rapid and radical redesign of strategic, value-added business processes - and the systems, policies, and organizational structures that support them - to optimize the work flows and productivity in an organization." [40] The BPR definition fits nicely into the proposed model for the effective management of SIM to maximize parts availability. The model indicates that increased material availability can be achieved by mitigating the variability factor of demand and by pooling existing personnel and material resources. However, for the model to be successful, the current logistic practices must undergo a strategic redesign with regards to existing systems, policies, and organizational structures.

1. Current Practice (MATCONOFF)

First, the systems that the Navy uses to manage SIM inventory are inadequate to accomplish the types of benefits that the model indicates. The closest formal procedure that exists is the Material Control Officer (MATCONOFF) concept that is generally promoted during battle group joint operations during deployment. Material Control Officer is a function typically in a battle group organization to facilitate the efficient provision and handling of repair parts. It requires manual screening for parts on other platforms. This system requires great human interactions and is dependent upon the forthright, diligent commitment to group success, and additional sound inventory practices for its success. The model is also characterized by the commitment to group success; however, the model focuses on reduction of manual labor requirements.

The amount of human interaction required for the MATCONOFF model to be successful is great. Additionally, when a MATCONOFF specialist transfers, tremendous

[40] Manganelli, R. and Klein, M, *The Reengineering Handbook: A Step-by-Step Guide to Business Transformation*, American Management Association, Mar 1996

historical knowledge may be lost and additional training would be required to bring another up to the level of proficiency. For example, the Navy employed a Storekeeper Second Class Petty Officer to serve as the MATCONOFF on Commander Task Force (CTF) 53 staff during Operation Noble Eagle in 2003. The petty officer became the "go to guy" for MATCONOFF issues. He was the holder of the MATCONOFF expertise.[41] However, when the petty officer transferred, his expertise moved with him and another person needed to be familiarized with the job. These types of retraining would not be necessary under the proposed model if the automation manager was more permanent and was able to accomplish similar management for a larger area of responsibility.

Secondly, the policies in place are not adequate to support the proposed model because of its novelty. The current policies are loosely written and the MATCONOFF procedures are not strictly enforced. MATCONOFF enforcements include management intervention for a non-compliant spoke member and further emphasis during selection criteria for logistics awards. However, the model would require a much more vigorous management technique to support its effectiveness. As potential transfers are identified through automation, logistics personnel must be held at a higher level of accountability for inventory validity and compliance with transfer directives as material demand is generated. These concepts are both common with the model and the MATCONOFF system.

Lastly, one of the largest shifts would be in the traditional organizational structure of the potential participants in the logistics of requisition filling. Currently, commands operate in a much more autonomous fashion when it comes to requisition filling. Generally, SUPPOs and commanding officers are most concerned with their commands logistics needs. This is a natural survival instinct; however, more overall and total benefit may be achieved if higher visibility is given to asset availability and requirements. This is a concept generally supported by Total Asset Visibility (TAV).

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41 http://www.news.navy.mil/search/display.asp?story_id=11884 (last accessed: 04Oct2005)

2. Scott's Virtual Stock Consolidation Model[42]

Virtual SIM inventory consolidation with emergent transshipments is the basis for the new model. First, this paper looks at DOD inventory consolidation practices in progress. Next it defines critical terms that affect part availability. Then it establishes a flow diagram and description of how a consolidated SIM inventory should behave. And finally it conducts an efficiency analysis based on status quo and generic consolidated SIM inventory.

B. INVENTORY CONSOLIDATION

The costs, benefits and efficiencies of inventory consolidation are being explored by both DOD and the commercial sector. The benefits of inventory consolidation are realized by distributing the demand for individual units over a larger inventory pool[43] Defense Logistics Agency (DLA) is leading DOD in finding ways to consolidate common items among the services to achieve greater availability and cost reductions. The commercial sector has already begun pressing forward with the idea of stock consolidation and much research has been accomplished to support the validity of the benefits from inventory consolidation.

1. DoD's Consolidation

Defense Logistics Agency (DLA) is working with the Army and the other services to establish a new inventory management strategy. The new approach is called the National Inventory Management Strategy (NIMS), and its object is to integrate the various wholesale and retail inventory with a centrally managed inventory. NIMS overall objectives are

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[42] This is a rudimentary and untested model. Scott Giles is a member of the project team who performed the statistical analysis and looked into stock consolidation models.

[43] Evers, P. T. and Beier F. J. (1998; 19, 1), *Operational aspects of inventory consolidation decision making*. Journal of Business Logistics. p. 55

1.) Provide DLA with a clearer view of immediate stock requirements by shifting DLA's focus from being a wholesaler to being a retailer;

2.) Reduce overall inventory levels by eliminating redundancy among the services; and

3.) Improve responsiveness by managing commodities from acquisition to the point of consumption.

a. *Wholesaler to Retailer*

With DLA's shift from wholesaler to retailer, the agency will become more involved in the day-to-day inventory management for the various end users. Whereas DLA previously supported the logistic operations of the various services by stockpiling commodities and providing supplies to the assorted supply systems, under the new strategy DLA will interface with the end user to satisfy requirements as they are generated. This strategy will effectively reduce the layers between suppliers and users by combining DLA's consumable inventory with the services' retail inventory into a national inventory that can be managed as a retail inventory by DLA. Basically, DLA will assume both wholesale and retail responsibilities. Additionally, the strategy will provide the supplier with a clearer picture of demand and the user with a clearer picture of asset availability thus improving overall readiness by ensuring that existing supplies are effectively matched with existing requirements.

b. *Inventory Reductions*

Inventory centralization often results in significant benefits which include cost reductions and/or improved effectiveness. DLA wishes to reap the cost reduction benefits of inventory centralization by reducing the amount of inventory required to achieve equal readiness. By pooling demand, DLA will be able to provide a larger total inventory for DOD and will improve cross-leveling of supplies and better meet demand across the services. According to DLA, "The consolidation of consumable inventory under a national manager will improve the effectiveness of total asset visibility for all of the services." In other words, when DLA pool the assets of the various services, the increased demand visibility will reduce variability of supply and demand and increase overall inventory effectiveness.

c. *Centralized Intermediate Repair Facilities (CIRF)*

CONUS centralized intermediate repair facilities (CIRFs) could potentially improve Air Expeditionary Force (AEF) support effectiveness and reduce maintenance manpower requirements. The Air Force has implemented CONUS CIRFs as part of its maintenance efforts. CIRF and depot repair are centrally located to maximize the distribution activities and achieve the greatest operational effectiveness under limited resources such as spare parts storage and transport. Because complete centralization may not necessarily be best in every situation, varying degrees of centralization are being attempted to optimize the quality and cost benefit. These attempts at centralizing resources are expected to improve Air Force's maintenance capabilities, as depots can be fitted with up-to-date maintenance equipment and can consolidate their spare parts storage.

C. MATERIAL AVAILABILITY

1. Concept of Mean Time Between

Mean Time Between (MTB) is a generic logistic measurement that looks at the total number of system life units divided by the total number of occurrences during a stated period of time. A MTB measurement looks at various aspects of logistic reliability and maintainability; these include Mean Time Between Failure (MTBF), Mean Time Between Maintenance (MTBM) and Mean Time Between Demand (MTBD). MTBD, also known as Mean Time Between Replacement (MTBR), is a measure of system reliability related to demand for logistic support. It is the total number of system life units divided by the total number of system demands on the supply system during a stated period of time.

The basic object of SIM management is to enhance the probability that high usage repair parts will be available when needed. Ultimately, greater part availability (A_p) will improve overall weapon system readiness, as repair parts are a critical aspect of both preventive and corrective maintenance which feed into overall weapon system readiness. A_p is a measure of how often a particular part is available when desired and is a function of both Mean Time Between Demand (MTBD) and Mean Transit Time (MTT). Both MTBD and MTT will be addressed in following sections; however, A_p is directly proportional to MTBD and inversely proportional to MTT. In other words, as MTBD increases so does A_p and the opposite holds true for MTT.

MTBD is used to determine sufficient inventory levels to achieve desirable A_p. MTBD is driven by both corrective and preventive maintenance as both may generate requirements for part support. The other factor that affects A_p is MTT. MTT is the transit time measured from the time that a part is ordered until it is received. Acceptable preventive and corrective maintenance can only be achieved with adequate A_p. When A_p is inadequate maintenance suffers and weapon system availability decreases.

2. Deriving A_p

Blanchard and Fabrycky state that availability can be expressed and defined in three ways:

1) Inherent Availability (A_i);

2) Achieved Availability (A_a); and

3) Operational Availability (A_o).

A_o will be reviewed below as this measure will be used to establish method to calculate A_p.[44]

Mean Time Between Maintenance (MTBM) is a measure of frequency of maintenance actions and is comprised of two components, Mean Time Between

[44] Blanchard, B. S., and Fabrycky, W. J., *Systems Engineering and Analysis*, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1981.pp. 336-337

Corrective Maintenance ($MTBM_c$) and Mean Time Between Preventive Maintenance ($MTBM_p$). $MTBM_c$ measures corrective maintenance actions; corrective maintenance actions become necessary when a weapon system fails. $MTBM_p$ measures preventive maintenance actions for a weapon system. Preventive maintenance actions are accomplished to minimize the likelihood of an unscheduled maintenance.

MTBF or Mean Time Between Failures is a measure of how often a weapon system fails. MTBF affects both MTBM and MTBD. MTBM is a function of unscheduled maintenance actions and scheduled maintenance actions. MTBM and MTBF are directly related; as MTBF and $MTBM_c$ decrease MTBM decreases as well. The same relationship exists between MTBM and preventive maintenance; as $MTBM_p$ decreases, MTBM decreases.

MTBD and MTBF are sometimes incorrectly used interchangeably. The two are the same only when all failures are a result of a particular repair part. However, part failure is not always the reason for a weapon system failure, and system failure is not normally the result of one particular part. MTBF may be generated by parts failure, operator failure, a combination of part and operator failure, a combination of parts failure or various other variables that can cause a system failure.

As with MTBF and $MTBM_c$, $MTBM_p$ and MTBD are the same only when a particular part is used every time a preventive maintenance is accomplished for the weapon system. Because MTBD is a measure for a particular part, and rarely is a particular part used solely for every preventive maintenance action, the chances that MTBD will equal weapon system $MTBM_p$ are minute.

Unlike $MTBM_p$, $MTBM_c$, or MTBF, MTBD focuses on the availability of a specific part. The others measure the availability of a major weapon system such as a sonar operating system or an attack aircraft, while MTBD would measure the availability of a part required to fix a sonar operating system or an attack aircraft.

A_o is the probability that a weapon system or piece of equipment will operate satisfactorily when called upon. Two factors affect A_o, MTBM and MDT. MTBM is addressed earlier. MDT is the Mean Down Time and measures the amount of time that the weapon system is down as a result of maintenance, logistics and administrative delays. Figure 6 shows the calculation formula for A_o.[45]

A_p is the probability that a part will be available onboard a ship when ordered. The formula for calculating A_o was modified to calculate A_p. MTBD was substituted for MTBM as a measure of how frequently the action occurs that pulls the asset out of use. Neither is the major driver of the availability calculation because they are in the numerator and numerator and denominator of the equation. MTT is substituted for MDT as MTT is a measure of logistics and administrative delays that prevent the demand from being filled.

Figure 5. Operational Availability

$$A_o = \frac{\text{Mean Time Between Maintenance}}{\text{Mean Time Between Maintenance} + \text{MDT}}$$

This project does not look at MTBF or MTBM but instead looks at MTBD as this is a more direct approach to measuring parts availability and overall SIM effectiveness. It focuses on MTBD to calculate A_p where MTBM would give operational availability of a weapon system or major piece of equipment. Figure 7 shows how A_p is computed.

Figure 6. Material Availability

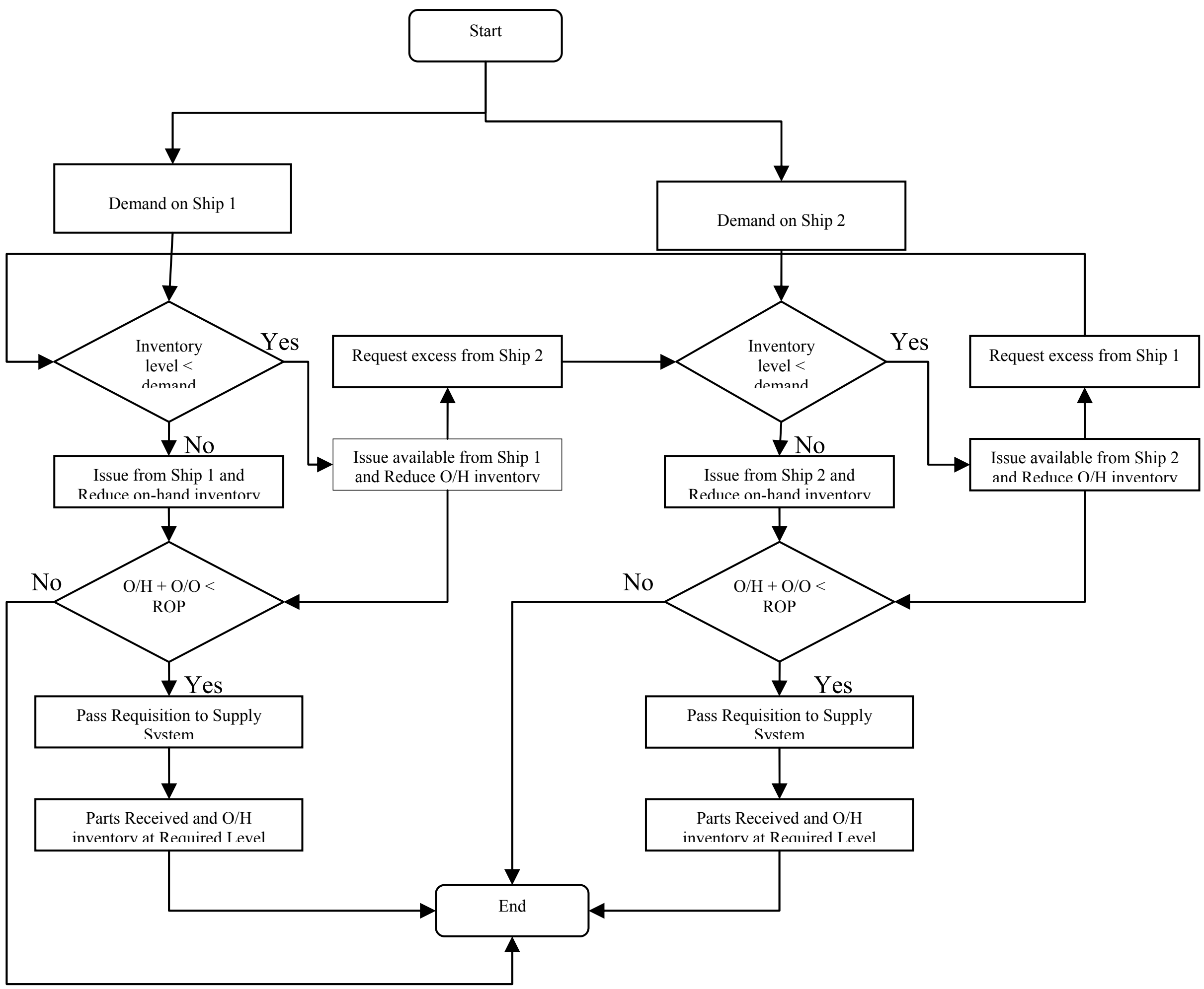
$$A_p = \frac{\text{Mean Time Between Demand}}{\text{Mean Time Between Demand} + \text{MTT}}$$

45 Blanchard, B. S., and Fabrycky, W. J., *Systems Engineering and Analysis*, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1981., p.337

D. NEW MODEL DIAGRAM AND DESCRIPTION

The model for a consolidated SIM inventory will behave much like a model identified by Sven Axsäter. However, the SIM inventory model consists of three levels whereas Axsäter's model consists of two levels. As with Axsäter's model emergency lateral transfers are allowed, but the transfers will be between ships and not bases.

Figure 7. Scott's Virtual Inventory Model



When an item fails, a requirement for a replacement part is identified and requisitioned by maintenance personnel through the ship's stock control, and if a good part is located on board the ship, shipboard stock control issues the part and orders another from the Navy's supply system to replenish the inventory.

If the part is not on the ship, supply automation begins to screen collocated ships and land based commands for the part. If the part is found at a collocated command, the part is pulled from that inventory and sent to the ship in need of the part. Supply automation then passes a requisition to the supply system for the borrowed part to be replaced. The part is shipped back to the ship that gave the loaner. Figure 8 above illustrates the flow of the model.

E. ANALYSIS AND RESULTS

The project analyzed the feasibility of the model by comparing current A_p (A_{p0}) to an achievable A_p (A_{p1}). Data were collected from COMNAVSURFPAC on SIM parts usage demand. MTBD and MTT were calculated for each item. MTBD was determined by calculating the mean number of days between each occurrence where the part was requisitioned by a ship. MTT was calculated by taking a mean of the number of days between when the item was ordered until the item was received for each individual requisition. A_{p0} was calculated by dividing MTBD by the sum of MTBD and MTT.

A_{p1} was calculated by dividing MTBD by the sum of MTBD and MTT_1. MTT_1 is an assumed transit time of 12 days. This value was chosen as a general assumption that three days is needed to package an item for shipment from a loaner ship, seven days for transit, and finally two days for receipt processing.

The results of the analysis show that with the new model Ap can increase by up to 12 percent. However, inventory managers may have the option to override the model, and 12 percent Ap increase may not be achieved. An override may be required if the inventory manager feels that the transshipment is not cost beneficial because the tradeoff between shipping distance and actual transit time may not support transshipment. Table 17 shows selected samples of MTBD, MTT, and A_p values.

Table 17. A_{p0} and A_{p1} Comparisons

NIIN	NOMENCLATURE	MTBD	MTT	MTT_1	A_{p0}	A_{p1}
01-146-0160	INDICATOR,RATE OF F	30	7	12	0.81	0.71
01-138-8937	VALVE,SOLENOID	26	8	12	0.75	0.68
01-442-3691	LIQUID COOLED CRTS-GREEN	7	22	12	0.24	0.36
01-212-9979	VALVE,SOLENOID	12	14	12	0.47	0.51
01-264-7753	VALVE,REGULATING,FL	4	11	12	0.26	0.25
01-092-4761	ELECTRON TUBE	256	196	12	0.57	0.96
00-201-2970	RELAY,OVERLOAD	6	22	12	0.22	0.35
01-255-9276	FAN,TUBEAXIAL	4	21	12	0.16	0.25
01-207-0153	POWER SUPPLY	14	6	12	0.7	0.53
01-304-5277	SEAL ASSEMBLY,SHAFT	52	75	12	0.41	0.81
01-443-5608	LIQUID COOLED CRTS-	20	32	12	0.39	0.63
01-442-3685	LIQUID COOLED CRTS-RED	12	24	12	0.33	0.5
01-168-9768	POWER SUPPLY	15	44	12	0.26	0.56
01-252-5439	DISTRIBUTION BOX	2	15	12	0.13	0.16
01-468-6207	X-TERMINAL,LANDSCAPE	12	13	12	0.48	0.51
01-264-6933	RADIATOR ASSEMBLY	59	75	12	0.44	0.83
01-462-9466	SEAL ASSEMBLY KIT	25	30	12	0.45	0.68
01-201-2572	BRAKE DISC PACK ASS	18	7	12	0.71	0.59
01-110-6377	VALVE,SOLENOID	8	25	12	0.23	0.39
					0.43	0.55

F. CONCLUSION

Conceptually the model and the idea of inventory consolidation bring about gains in overall parts availability. To achieve this model in actuality, a BPR must occur. First, the way that the Navy's supply system is structured needs to change. Currently, the system does not support transshipments in an efficient manner. To achieve this function supply personnel must massage the system to ensure that the desired part arrives at the desired location. And many times with the additional massaging the part does not move as desired.

Secondly, the emphasis must be shifted from single unit performance to a team of units' performance. Basically, all SUPPOs and supply personnel are currently evaluated and awarded based on the performance of their operation. To achieve more teamwork between units, the reward system would need to be addressed so that units that support the team are rewarded down to the junior supply personnel level, and the junior supply personnel must know that they are being rewarded for this purpose. They must realize what they need to do to achieve the reward.

Lastly, inventory managers must still be involved in the process. This model does not solve all SIM inventory effectiveness issues. Inventory managers must still look at strategic location of inventory to minimize the need for transshipments. Additionally, managers must consider variances of transit time for both situations where ships transship or receive parts from the supply system and understand how that affects availability.

VIII. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSIONS

The project authors agree with the TYCOM's assertion that effective SIM inventory control and management is an essential element and a major contributing factor to the ship's overall combat readiness and capability. For these reasons, it is absolutely critical to the ship's mission that SUPPOs place a high degree importance on SIM inventory. Although much of the statistical correlation analysis conducted in this project produced inconclusive results with regards to the relationships between inventory practices and SIM effectiveness, the authors feel that the premise of the study should be studied further. The inconclusive results may be explained by the limited management practice data that were available for use in the analysis. The authors suggest that a more extensive and in-depth study be conducted to identify with a greater degree of certainty if correlations exist between management practices and SIM effectiveness. If such correlations can be established, further research should be undertaken to show that supply policies should be tailored to achieve the desired relationship between management practices and SIM effectiveness.

It is understood that SUPPO is ultimately responsible to the CO to ensure that the ship's maintenance effort and mission are sufficiently supported logistically. Most SUPPOs do meet issue effectiveness goals and adequately support their respective ships, but there are those who consistently fail to achieve the desired goals at the unfortunate expense of the ship's mission and combat readiness. It is incumbent upon the TYCOM to determine if misplaced management attention is to blame for these shortcomings and direct the SUPPOs through policy guidance to change certain practices.

Additionally, many of the comparisons between supply management practices and SIM effectiveness produced inconclusive results. Further research is required to determine the nature of the relationship between these practices and SIM effectiveness. It is of the utmost importance that practices which conflict with other supply management practices be identified to determine if there are ways to reduce the amount of competition or better maximize the degree of synergism between practices when possible.

Certain correlations, even though not significantly different for zero, suggest that SUPPOs may be in a reactive mode in which they are accomplishing sound SIM management practices after they encounter SIM effectiveness deficiencies. This idea does warrant further attention as SUPPOs and/or TYCOMs may be able to identify the lack of practices which will result in undesirable SIM effectiveness results and change management techniques before the problems are encountered. This is would be a change from a reactive approach where management practices are reviewed after a problem occurs to a proactive approach where management practices are reviewed before a problem occurs to prevent the occurrence.

In addition, the authors also feel that there are real value-added benefits in conducting a BPR through virtual stock consolidation. The benefits of virtual stock consolidation are possible because the risk of having a stock out is distributed over several inventory rather than one inventory. A 12 percent improvement in overall material availability was achieved with a model that allowed for emergent transshipments of SIM parts between ships. The benefits are mathematically arrived by using a comparison of current material availability and potential availability with a 12 day transit time. The added benefit of the model is that it does not require additional inventory to achieve the material availability improvements, but only requires a systematic change in the way that surface ships conduct business.

The authors do realize that the model is not a "solve all" for SIM effectiveness issues. The process of the model would require the involvement of supply personnel at all levels, as critical decisions must be made as rather to use the results of the model on a case by case basis. For example, transit times must be considered. If the transit time for the part coming from the supply system is estimated to be less than 12 days or if the transit time for the transshipment action is over 12 days, the inventory manager may decide against using the process outlined in the model. These are the types of decisions that requires human processing.

Although the concept of querying other ship's assets through the Fleet Inventory Management Asset Reporting System (FIMARS) is not new, the authors experience with FIMARS material screens is that FIMARS inventory data are outdated and not responsive to the dynamics of inventory usage and movement. The ships are required to upload FIMARS inventory data into the system only on a once a month basis. In this regard, the authors suggest the development of robust TAV platform or system that is updated real time or at least more frequently, preferably daily to better reflect the dynamics of inventory. Additionally, the authors recommend that a centralized virtual inventory manager be designated to monitor and manage SIM inventory data. Wal-Mart, Inc., the huge retailer, already has such a centralized inventory management system in use to monitor, reorder, and basically manage the inventory of their different stores.

B. RECOMMENDATIONS

1. Segregate Dependent Demand Elements from Independent Demand Elements

As discussed in Chapter V, shipboard demand is a hybrid of dependent and independent demand elements. The ships may already possess the automated inventory systems that already have the potential capability of identifying routine dependent demand spare parts requirements via the supply-maintenance interface of OMMS-NG and R-Supply programs. These periodic replacement parts and materials are specified in all the MRC cards in the 3-M program. The authors recommend that the Navy devise a system to capture these routine periodic material requirements and manage these portions of the inventory as dependent demand system where inventory replenishment can be timed and optimized.

2. Further Studies

It must be noted that this project did not specifically address costs and cost efficiencies intentionally. The authors recognized that cost factors are important and should be taken into account in any discussion about inventory. Nevertheless, in reality, cost or funding considerations, more often than not, frequently become a secondary factor when pitted against ship mission performance. In light of shrinking budgets and lean fiscal outlook, it is neither frugal nor efficient for the ships to constantly maintain a policy of 100% on-hand on order for spare parts all the time. In order for the Navy to realize cost efficiencies, it must first raise awareness through education, and it must tie-in cost metrics to inventory goals. The Navy must set optimal inventory goals against realistic funding constraints, and SUPPOs must now learn how to make tradeoff decisions between accepting a certain level of mission readiness for the given or affordable material availability based on a realistic budget.

3. Paradigm Shift

The virtual stock consolidation model has mathematically shown the potential material availability benefits. However, to achieve this potential the Navy would need to change the way that a requisition is routed. Furthermore, there must be a change in the supply reward system with a shift from individualistic performance measures to a system that rewards teamwork among personnel at all levels, SUPPOs, COs, even down to the junior enlisted level. The authors feel that without this shift in reward system, the average person may be tempted to resort to self-interest and will do what works best for his command as he is unable to realize or appreciate the risk mitigation among the fleet of ships and their inventory. There is a temptation to focus on reducing self risk by keeping for later use than transferring it to accomplish an immediate need.

4. Cost Benefit Analysis

The improved material availability calculations were accomplished with mean transit time and mean time between demand. The results of these calculations show an improved availability and would tend to show that this model is a viable option to achieve this improved availability. However, this project addresses the issue of using the model solely from an availability perspective. The authors recommend that the Navy conduct a thorough CBA to determine if this model works well with the fiscal prudence of shifting from the current manner of conducting business. Some of the key points that must be considered when determining the overall cost are the information technology required to support this model, the training requirements to accommodate the transition, and the transportation costs of moving parts between ships. The benefits of the model must be addressed in terms of cost of the inventory necessary to achieve the improved availability, potential transportation cost savings achieved by close proximity of ships and a reduction in the amount of expedient transportation, and finally overall cost reductions achieved by maintaining higher operational availability of weapon systems.

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APPENDIX A: SURVEY QUESTIONNAIRE

SUPPOS SURVEY

Ship name: ___________________________

1. Based on a standard 40-hour workweek, provide an estimated number of hours per week that you spend or devote to **managing your S-1 division (stock control operations)**? Please indicate with a check or **X** mark.

Less than 5 hours/week	
Between 6-10 hours/week	
Between 10-15 hours/week	
More than 16 hours/week	

Provide additional comment if any: ____

i.e. (the other divisions had problems that required closer attention, other command requirements/collateral duties (DCTT) demand your attention, etc.)

2. In S-1, based on a standard 40-hour workweek, provide an estimated number of hours per week that you spend or devote to **DLR MANAGEMENT**? Please indicate with a check or **X** mark.

Less than 5 hours/week	
Between 6-10 hours/week	
Between 10-15 hours/week	
More than 16 hours/week	

Provide additional comment if any: ____

3. In S-1, based on a standard 40-hour workweek, provide an estimated number of hours per week that you spend or devote to **SIM/DBI MANAGEMENT**? Please indicate with a check or **X** mark.

Less than 5 hours/week	
Between 6-10 hours/week	

Between 10-15 hours/week	
More than 16 hours/week	

Provide additional comment if any: ____

4. In S-1, based on a standard 40-hour workweek, provide an estimated number of hours per week that you spend or devote to **FINANCIAL MANAGEMENT**? Please indicate with a check or **X** mark.

Less than 5 hours/week	
Between 6-10 hours/week	
Between 10-15 hours/week	
More than 16 hours/week	

Provide additional comment if any: ____

5. In S-1, based on a standard 40-hour workweek, provide an estimated number of hours per week that you spend or devote to **COSAL MANAGEMENT**? Please indicate with a check or **X** mark.

Less than 5 hours/week	
Between 6-10 hours/week	
Between 10-15 hours/week	
More than 16 hours/week	

Provide additional comment if any: ____

6. In S-1, based on a standard 40-hour workweek, provide an estimated number of hours per week that you spend or devote to **REORDER REVIEW**? Please indicate with a check or **X** mark.

Less than 5 hours/week	
Between 6-10 hours/week	
Between 10-15 hours/week	
More than 16 hours/week	

Provide additional comment if any: ____

7. In S-1, based on a standard 40-hour workweek, provide an estimated number of hours per week that you spend or devote to **CMP REPORT MONITORING/MANAGEMENT**? Please indicate with a check or **X** mark.

Less than 5 hours/week	
Between 6-10 hours/week	
Between 10-15 hours/week	
More than 16 hours/week	

Provide additional comment if any: ____

8. Which inventory TYCOM GOALS (from the CMP report) do you put more management effort into and consider more important. Please prioritize all, number 1 being your highest priority. (*Sorry, no easy out with saying all are equally important).*

TYCOM CMP Report	Priority
Net Issue Effectiveness Rate	
Gross Issue Effectiveness Rate	
SIM/DBI 100% On-hand or On Order	
AT6 - Excess Dollar amount/Qty	
Inventory Range and Depth	
SIM/DBI Issue Effectiveness Rate	
Carcass Bill goals (less than 3-5% of DLR throughput)	

Provide additional comment if any: ____

9. Which inventory TYCOM GOALS (from the CMP report) do you think are most important to your CO? Which ones do you get more questions in? Please prioritize all, number 1 being the CO's highest priority. (*Sorry, no easy out with saying all are equally important. Put your best guess on your CO's priorities).*

TYCOM CMP Report	Priority
Net Issue Effectiveness Rate	
Gross Issue Effectiveness Rate	
SIM/DBI 100% On-hand or On Order	
AT6 - Excess Dollar amount/Qty	

Inventory Range and Depth	
SIM/DBI Issue Effectiveness Rate	
Carcass Bill goals (less than 3-5% of DLR throughput)	
Reorder Codes	

Provide additional comment if any: ____

10. In S-1, based on a 5-day workweek, how often do you drop/submit your repair parts stock reorder to FISC? Please indicate with a check or **X** mark.

Daily	
More than once a week	
Once a week	
More than once a month	
Once a month	

Provide additional comment if any: ____

11. Which area of supply management did you best grasp at Supply School (BQC, SODHC, or other supply schools you've attended)? Please rank all.

DLR Management	
SIM/DBI Management	
Financial Management	
COSAL Management	

Provide additional comment if any: ____

12. Which area of supply management do you think does your S-1 senior enlisted leadership (E6 and above) understand the best? Please rank all.

DLR Management	
SIM/DBI Management	
Financial Management	
COSAL Management	

Provide additional comment if any: ____

13. Provide any comments that you feel are relevant to supply inventory management, especially in the area of SIM/DBI management.

Thank you for taking the time answering this informal survey. Please submit as an attachment to miaxinto@nps.navy.mil and to msgiles@nps.navy.mil

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APPENDIX B: SURVEY DATA

HULL *	SURVEY QUESTIONS					
	q1	q2	q3	q4	q5	q6
CG1	3	3	3	12	3	3
CG2	8	3	3	8	3	3
CG3	12	3	3	8	3	3
CG4	18	3	3	12	3	3
CG5	12	8	3	8	3	3
DDG1	12	3	3	8	3	3
DDG2	18	3	3	8	3	3
DDG3	8	3	3	3	3	3
DDG4	12	3	3	8	3	3
DDG5	18	3	3	3	3	3
DDG6	8	3	3	3	3	3
DDG7	3	3	3	3	3	3
DDG8	3	3	3	3	3	3
DDG9	12	3	3	8	3	3
DDG10	8	3	3	3	3	3
DDG11	18	3	3	8	3	3

HULL *	SURVEY QUESTIONS					
	q7	q8.1	q8.2	q8.3	q8.4	q8.5
CG1	3	1	1	0	0	0
CG2	3	1	0	1	0	0
CG3	3	0	0	1	0	1
CG4	3	1	0	0	0	1
CG5	3	1	1	0	0	0
DDG1	3	1	0	1	0	0
DDG2	3	0	0	1	0	1
DDG3	3	1	1	0	0	0
DDG4	3	1	1	0	0	0
DDG5	3	0	0	1	0	0
DDG6	3	1	1	0	0	0
DDG7	3	1	1	1		
DDG8	3	1	0	1	0	0
DDG9	3	1	0	1	0	0
DDG10	3	1	1	1	0	0
DDG11	8	1	1	0	0	0

HULL *	SURVEY QUESTIONS					
	q8.6	q8.7	q9.1	q9.2	q9.3	q9.4
CG1	0	1	1	1	0	0
CG2	0	1	1	0	1	0
CG3	0	1	0	0	1	0
CG4	0	1	1	1	0	0
CG5	0	1	1	1	0	0
DDG1	0	1	0	0	1	0
DDG2	1	0	1	1	0	0
DDG3	0	1				
DDG4	0	1	1	1	0	0
DDG5	1	1	0	1	0	0
DDG6	1	0	1	1	1	0
DDG7						
DDG8	0	1	1	1	0	0
DDG9	0	1	1	0	0	0
DDG10	0	0	1	0	0	1
DDG11	1	0	1	1	0	0

HULL	SURVEY QUESTIONS					
	q9.5	q9.6	q9.7	q10	q11.1	q11.2
CG1	0	0	1	0.10	2	
CG2	0	0	1	0.10	1	1
CG3	1	0	0	0.10	2	2
CG4	0	0	1	0.05	1	3
CG5	0	0	1	0.05	1	3
DDG1	0	1	1	0.05	1	2
DDG2	0	0	1	0.05	2	2
DDG3				0.05	1	2
DDG4	0	0	1	0.10	1	2
DDG5	0	1	1	0.05	1	
DDG6	0	0	0	0.05	2	2
DDG7				0.10		
DDG8	0	0	1	0.10	1	3
DDG9	0	0	1	0.10	1	
DDG10	0	0	1	0.10	2	2
DDG11	1	0	0	0.20	2	2

HULL	SURVEY QUESTIONS					
	q11.3	q11.4	q12.1	q12.2	q12.3	q12.4
CG1	1		1	2	4	2
CG2	2	3	2	2	1	4
CG3	1	4	3	3	4	1
CG4	4	3	1	2	2	4
CG5	3	4	3	3	1	4
DDG1	2	4	1	2	2	4
DDG2	1	4	2	2	1	4
DDG3	2	3	1	3	3	4
DDG4	2	4	3	3	1	4
DDG5					1	
DDG6	1	4	1	2	2	4
DDG7						
DDG8	3	4	1	2	2	4
DDG9				4		
DDG10	1	4	2	2	1	4
DDG11	1	4	1	1	2	3

*Note: Hull numbers were changed to maintain anonymity of respondents.

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APPENDIX C: SHIPS ISSUE EFFECTIVENESS RATES

HULL*	Avg Net Effectiveness rates
CG1	89%
CG2	91%
CG3	90%
CG4	98%
CG5	100%
DDG1	89%
DDG2	74%
DDG3	81%
DDG4	96%
DDG5	97%
DDG6	94%
DDG7	54%
DDG8	80%
DDG9	100%
DDG10	96%
DDG11	86%

*Note: Hull numbers were changed to maintain anonymity of respondents.

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